26.158

5001 TRANSISTORIZED DIGITAL VOLTMETER MODEL 26.158

EAI

ELECTRONIC ASSOCIATES INC. ■ LONG BRANCH, NEW JERSEY

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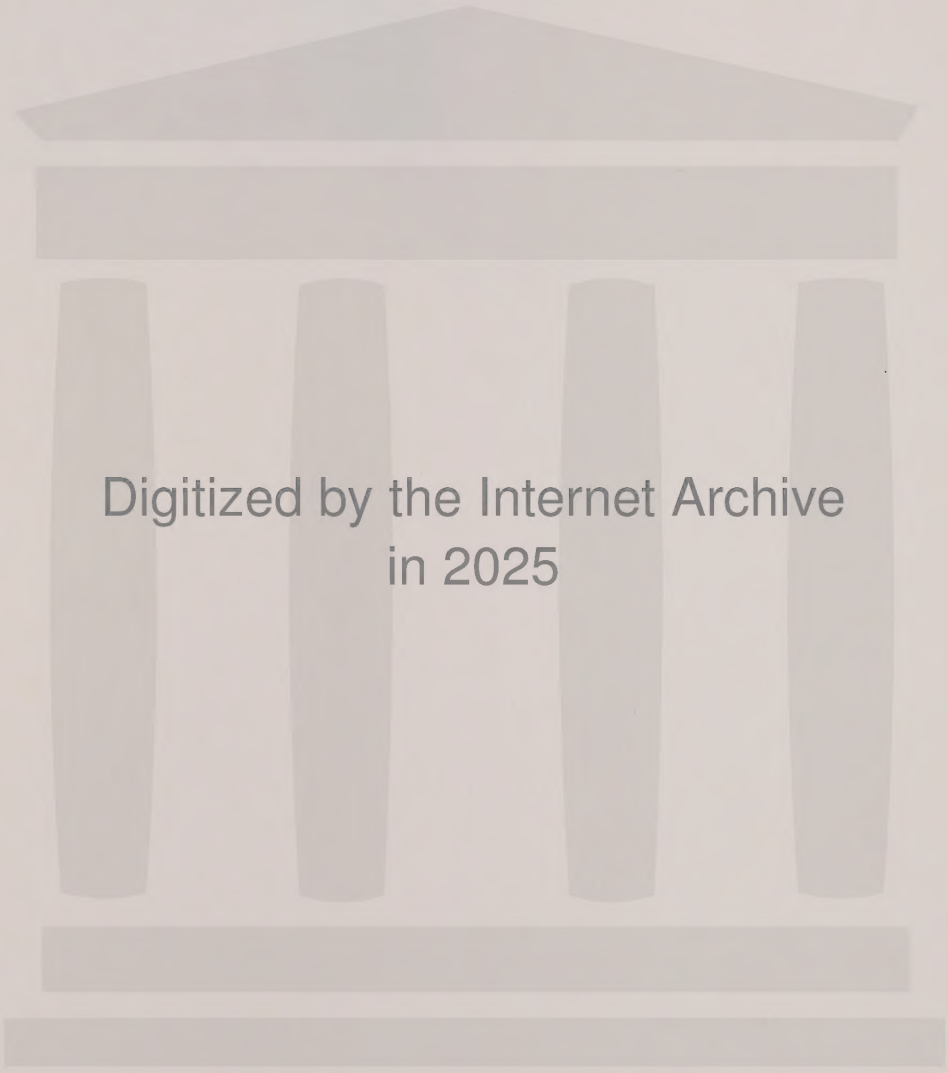
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Figure 1. 5001 Transistorized Digital Voltmeter (With Dust Cover)

CHAPTER I

GENERAL DESCRIPTION

1. FUNCTION

The 5001 Transistorized Digital Voltmeter (TDVM), designed and manufactured by EAI (Electronic Associates, Inc.) is a fast acting, high precision instrument for d-c voltage measurement. This instrument (Figures 1 and 2) features both automatic and manual range selection with overload protection when operated in the manual range-selection mode. The readout is presented on a high-brilliance optical readout system which permits wide angle viewing even under adverse ambient light conditions. Readout representation of the measured potential is presented as a five-digit decimal display plus the polarity sign and decimal point.

The 5001 TDVM presents *full-time* input impedance to the input source; this input impedance is not dependent on a *null* condition of the TDVM. This feature eliminates variable loading of the input voltage source during the TDVM sampling cycle. The 5001 samples and reads out the unknown potential on the average of 200 readings per second (without a sign change or change in TDVM range).

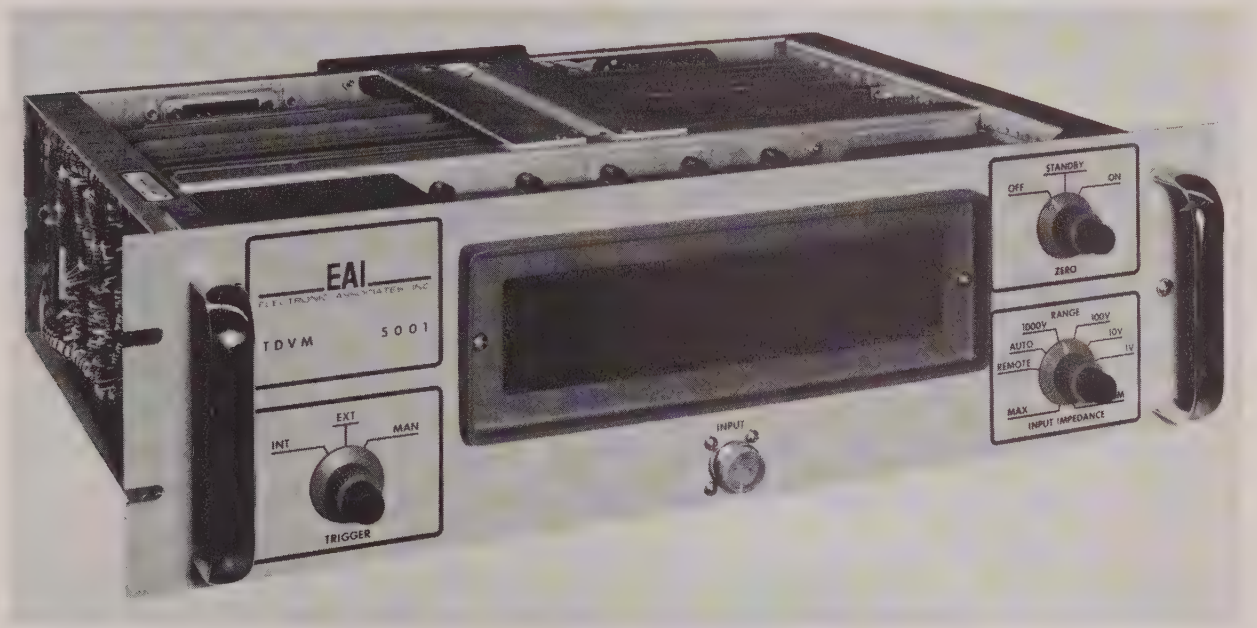


Figure 2. 5001 TDVM as Furnished for Rack Mounting

The 5001 TDVM is capable of accurately measuring voltages from zero to 1000 volts (plus 20% over range) in four ranges: 0 to 1 volt, 0 to 10 volts, 0 to 100 volts, and 0 to 1000 volts. Input impedance ranges from 250 megohms (or greater) on the 1 volt range and 500 megohms (or greater) on the 10 volt range, to 10 megohms on the 100 and 1000 volt ranges. A switch is provided for the 1 and 10 volt ranges which permits setting the impedance to 10 megohms. This feature is incorporated to provide equal loading to input signals in all four of the TDVM ranges. Comparative readings of greater accuracy with respect to each readout range are therefore available to the operator.

Increased flexibility of the TDVM usage is provided by supplying output signals (in both straight decimal and binary-coded decimal form) representing the voltage being measured. These signals are terminated at a connector on the rear of the TDVM chassis to facilitate their usage in driving such external equipment as a remote visual indicator, a card or tape punch, or a high-speed printer.

The TDVM, by using a programmed-comparision type of meter circuit and utilizing transistorized circuitry throughout (thus eliminating stepper switches), provides quiet, reliable, accurate, and long-term trouble-free operation. Easily adjusted controls assure high accuracy over extended field use. Interchangeability of many of the printed circuit cards aids in maintenance and repair of the instrument.

The 5001 TDVM features a floating ground system which permits the measurement of the d-c potential difference between two voltage sources.

2. PHYSICAL DESCRIPTION

The 5001 TDVM is designed for use as either a rack-mounted (Figure 2) or portable bench instrument. All components are contained (including power supplies and stable reference source) in a 19-inch chassis compatible with standard RETMA rack requirements.

A majority of the TDVM components (with exception of the power supplies and certain networks) are mounted on removable printed-circuit cards that plug into chassis-mounted connectors. Table I lists the various printed circuit cards, the circuit designation, and the chassis-mounted connector designation. The physical location of each card is shown in Figures 3 and 4.

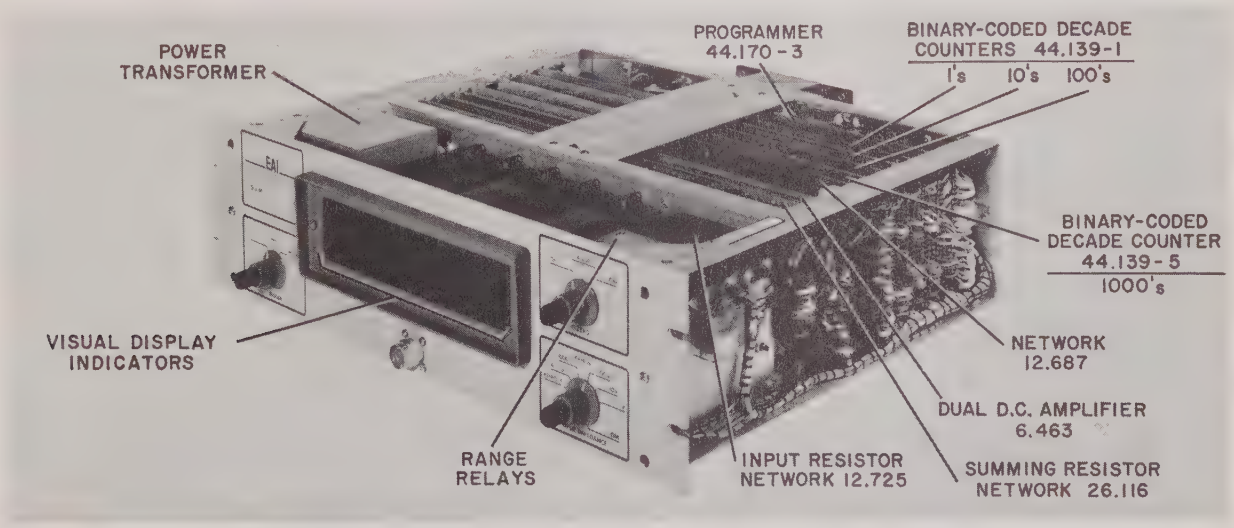


Figure 3. Chassis Component Location (Front View)

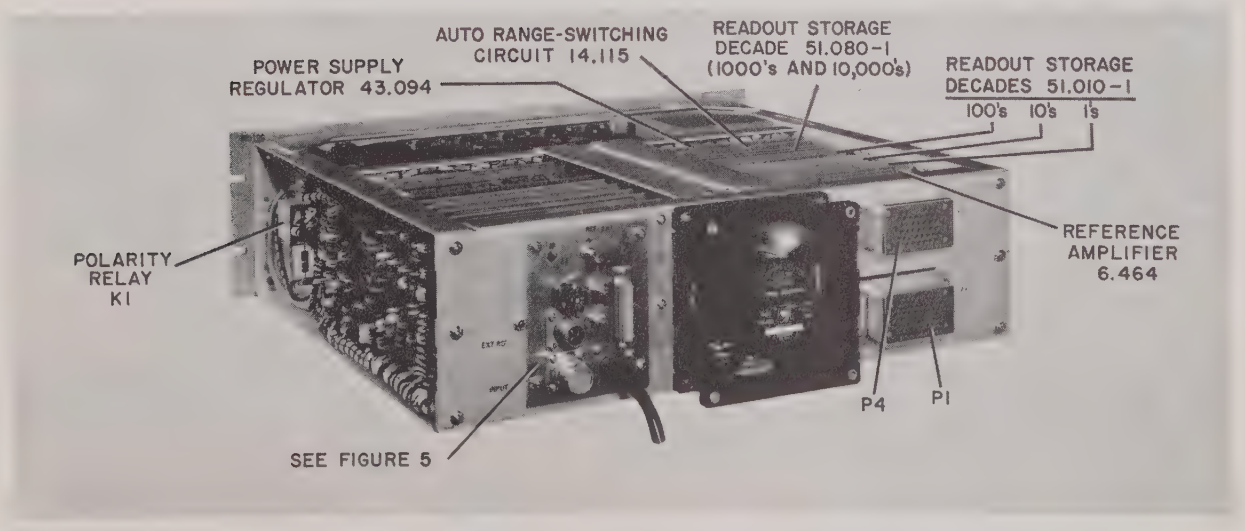


Figure 4. Chassis Component Location (Rear View)

TABLE I

CARD NOMENCLATURE	MODEL NUMBER	QUANTITY REQUIRED	CIRCUIT AND CHASSIS CONNECTOR DESIGNATION
Dual D. C. Amplifier	6.463	1	AR1-J1
Reference Amplifier	6.464	1	AR2-J1
Comparator and Diode Gate	26.096-1	1	A1-J1
Binary Coded Decade Counter	44.139-5	1	A2-J1 (1000's)
Binary Coded Decade Counter	44.139-1	3	A3-J1 (100's) A4-J1 (10's) A5-J1 (1's)
Programmer	44.170-3	1	A6-J1
Readout Storage Decade	51.010-1	3	A7-J1 (1's) A8-J1 (10's) A9-J1 (100's)
Readout Storage Decade	51.080-1	1	A10-J1 (1000's)
Auto Range Switching	14.115	1	A11-J1
Summing Resistor Network	26.116	1	NW2-J1
Miscellaneous Network Card	12.687	1	NW7-J1
Power Supply Regulator	43.094	1	VR1-J1

In addition to the plug in cards, certain other components are in the form of network assemblies mounted on the TDVM. These units are listed in Table II.

TABLE II

NETWORK NOMENCLATURE	MODEL NO.	QUANTITY	CHASSIS DESIGNATION
Rectifier Network	12.675	1	NW8
Reference Amplifier Network	12.722	1	NW6
Input Resistor Network	12.725	1	NW1

Table III lists the physical dimensions of the TDVM.

TABLE III

CHASSIS (overall)	5-1/4 x 19 inch RETMA Panel 16 inches deep
COVER (overall)	Height ..... 6-1/4 inches Width ..... 19-1/4 inches Depth ..... 17-1/8 inches
WEIGHT	Chassis only ..... 25 pounds Chassis and cover ..... 40 pounds

3. TDVM ACCESSORY GROUPS

a. Accessory Installation Group 2.393

The Accessory Installation Group 2.393 provides the dust cover and necessary hardware for TDVM Model 26.158 if desired to use the TDVM as a portable bench instrument (Figure 1).

b. Accessory Installation Group 2.394

The Accessory Installation Group 2.394 provides the handles and necessary hardware for TDVM Model 26.158 if desired to rack mount the instrument (Figure 2).

4. TECHNICAL DATA AND SPECIFICATIONS

Ranges (Automatic or Manual Selection) ..... 0 to 1 volt +20% over range = 0 to 1.1999 volts

0 to 10 volts +20% over range = 0 to 11.999 volts

0 to 100 volts +20% over range = 0 to 119.99 volts

0 to 1000 volts +20% over range = 0 to 1199.9 volts

Input Impedance ..... Dependent on Range

Range	Impedance (Megohms)
1 volt	250 minimum*
10 volt	500 minimum*
100 volt	10
1000 volt	10

Maximum Readout Time ..... 0.35 seconds (automatic change of range, no polarity change)

0.7 second (both range and polarity change)

0.01 second (no change in either polarity or range)

Conversion Time ..... 0.005 seconds average**

Accuracy ..... ±0.01% of full scale (±1 digit on all ranges)

Resolution of Digital Presentation ..... 0.01% of full scale

Power Requirements ..... 115/230 volts, 50/60 cycles

Rated Operating Temperature ..... 55°F to 100°F

Temperature Coefficient ..... Readout change of 0.0005% per °F typical

Polarity Indicator ..... automatic

Range Switching ..... automatic, manual, or remote

Input ..... double ended

Trigger ..... internal, manual or external

The input impedance of the 1 and 10 volt ranges with careful adjustment may be set to even higher values. The INPUT IMPEDANCE switch also permits setting the impedance of these ranges to 10 megohms to agree with the 100 and 1000 volt ranges.

**The unknown input is sampled continuously at an average rate of 200 samples per second.*

CHAPTER II

INSTALLATION AND ADJUSTMENTS

1. CHASSIS INSTALLATION

As previously indicated the 5001 TDVM is designed for use as a bench instrument or for mounting in a standard 19-inch RETMA rack. Instruments for bench use are shipped in the heavy-duty dust cover and require no installation other than the external connections (if desired) described in Paragraph 2 of this chapter.

Unpack the TDVM from the shipping carton, and check that all components are in place and undamaged. To remove the chassis from the dust cover, first remove the two cover plates from each side of the front panel. This is readily accomplished by inserting a screw driver into the slot on the side of each cover plate and gently prying the plate loose. (Cover the screw driver blade with tape to avoid marring the front-panel finish.) Removing these plates exposes the four screws (one in each corner of the front panel) which fasten the dust cover to the front panel. By removing these screws and the two bottom screws, the TDVM chassis may be slid from the cover.

If the TDVM is to be rack mounted, the front panel should be fastened to the rack by running four screws (1/4-20 screws for an EAI rack and 10-32 screws for a standard RETMA rack) through the slotted holes on each side of the panel.

Secure these screws tightly. Although the TDVM chassis is sufficiently strong to permit rack-mounting without supporting the rear of the chassis, it is recommended that rear supports or side rails be installed in the rack. This will make the chassis easier to handle when removing the unit from the rack.

2. A.C. POWER CONNECTION

The 5001 TDVM is equipped with a standard 3-wire power cable for connection to a single-phase 115/230 volt source. If the power source is not wired for the 3-prong plug an adaptor is required. *If the adaptor is used, the green ground lead on the adaptor must be connected to an earth ground.* Also, check the polarization of the a-c line to be certain that the TDVM *hot* a-c lead (black) is connected to the *hot* side of the source.

The TDVM is designed for use with either 50 or 60-cycle power sources at 115 or 230 volts. (See D026 158 0S, Sheet 4.)

3. EXTERNAL CONNECTIONS

Several connectors are mounted on the rear of the TDVM chassis to provide for certain external control functions and electrical outputs. These connectors and their functions are listed in the following paragraphs.

a. EXT REF

This coaxial connector permits slaving the TDVM reference circuits to an external reference source of -100 volts. The adjacent switch (EXT/INT) provides selection of the reference source.

b. TEST POINT Connector

To facilitate adjustment and maintenance of the TDVM certain input and output points are wired to a connector on the rear of the TDVM (TEST POINT connector P2). These points include all power supply outputs, amplifier outputs, and some logic-switching voltages. The TEST POINT data may be used directly at the connector, or may be cabled to a central monitoring facility.

In addition, the terminals for balancing the two d-c amplifiers are terminated at the TEST POINT connector. The amplifier balance procedure is covered in Chapter III.

c. INPUT Connector

This coaxial jack (J3) is wired in parallel with the front panel connector.

d. Printer Connector P1

This 78-pin connector provides output signals and control functions to drive remote indicating devices, tape or card punches, or a printer. The following table describes the available outputs. (See Sheets 16 and 17 of Drawing B026 158 0W for a complete list of PRINTER connector terminations.)

TABLE IV

DATA OUTPUTS		
TYPE OF OUTPUT	FUNCTION	ELECTRICAL CHARACTERISTICS
Binary-Coded Decimal	1, 2, 4, 8 per decade	-6 (±.5) volts for *on*, -0.5 (±.2) volts for *off*. Source impedance of each line is about 3300 ohms.
Decimal	0-9 per decade	-7.5 (±.5) volts for *off*, -1 (±.5) volt for *on*. Each source can provide up to 1 ma of load current.
Decimal Position	1's, 10's, 100's, or 1000's	See area C-1 on Sheet 1 of D026 158 0S (terminals 45 and 46 of connector P1).
Polarity Indication	+,-	See area E-1 on Sheet 1 of D026 158 0S (terminals 70 and 71 of connector P1).
Finish-Reading Pulse	Indicates decimal and BCD outputs set to new readings.	200 microsecond positive-going pulse (from -7.5 volts to approximately +1.5 volts.

e. Programming Connector P4

This connector is provided to facilitate external command control of the TDVM. Functions such as range control and cycle command can be operated from a remote location. See Drawing B026 158 0W, Sheet 19 for a complete list of the PROGRAMMING connector terminations.

4. PRELIMINARY ADJUSTMENTS

Each TDVM is completely checked and factory-calibrated prior to shipment and should require no further adjustment upon receipt. A pre-operational check procedure is outlined in Paragraph 2, Chapter III of this handbook. Performing this check will enable the operator to determine that the instrument is operating properly. If trouble is encountered, refer to appropriate paragraphs in the chapters describing TDVM maintenance and calibration.

CAUTION

Calibration adjustments should not be performed unless the operator is certain that the instrument is out of calibration. Calibration of an instrument with the accuracy of the TDVM is a relatively difficult procedure, requiring the use of precision voltage sources and measuring facilities not normally available in field installations.

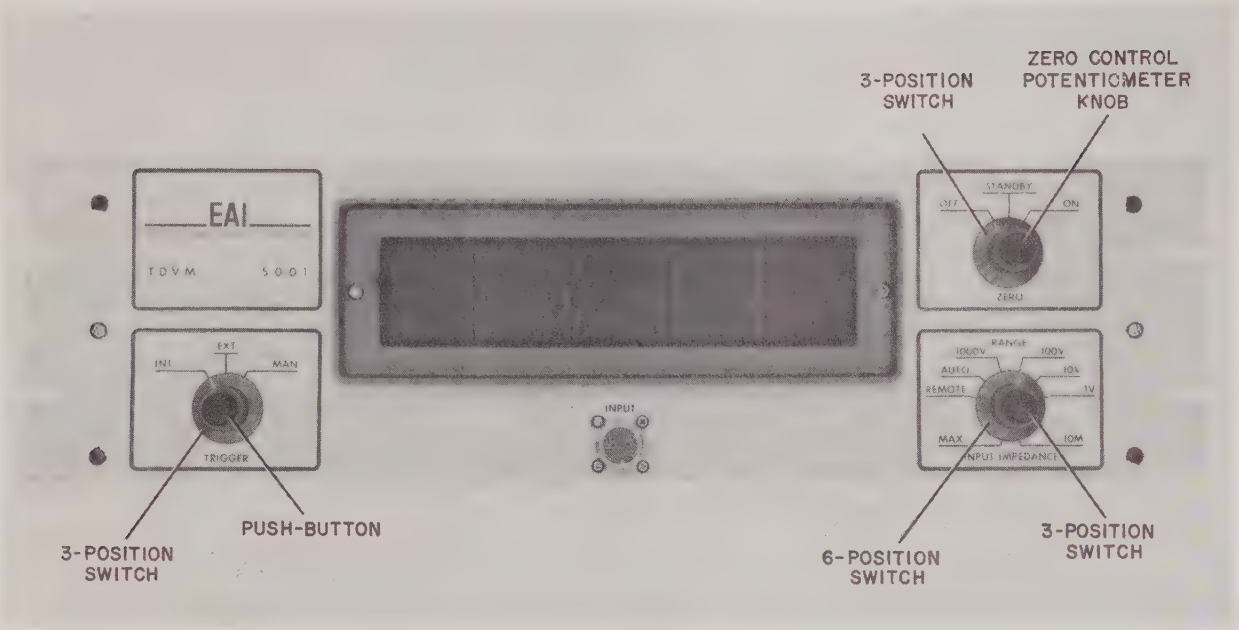
CHAPTER III

OPERATION

1. CONTROL FUNCTIONS

When using the TDVM the operator should be thoroughly familiar with all controls. Before operation, study the function of each control as described in the following table. (The first three controls listed are on the front panel; all others are rear-panel mounted. See Figure 5.)

CONTROL	FUNCTION
OFF-STANDBY-ON and ZERO control	The outer light-colored portion of this dual control is the OFF-STANDBY-ON, three-position power control selector. In the STANDBY position the input circuits remain open, but all power supplies are energized. The instrument is therefore ready for instantaneous operation by placing the switch in the ON position. In the ON position, in addition to maintaining the power supplies energized, the INPUT jacks are connected to the input amplifier and the 1 and 10 volt range unloading circuits are also connected to the input amplifier. The dark inner portion is the ZERO control. This control permits zero-setting of the indicators.
RANGE and INPUT IMPEDANCE Control	The outer light-colored portion of this dual control is the RANGE switch. The REMOTE position permits remote *manual* range selection or switching of the instrument into *automatic* selection from a remote position. The AUTO position switches the instrument into the automatic range selection mode. The remaining four positions are for manual selection of the desired range. The inner dark portion of the control is a two-position INPUT IMPEDANCE switch used in conjunction with the 1 and 10 volt ranges. In the MAX position the instrument offers maximum impedance on the 1 and 10 volt ranges; in the 10M position the 1 and 10 volt range impedances are decreased to 10 megohms thus matching the impedance of the 100 and 1000 volt ranges.
INT-EXT-MAN and TRIGGER Control	The outer light-colored portion of this dual control is the INT-EXT-MAN three-position cycle command function switch. In the INT position the TDVM sampling cycle is internally controlled and free-runs at an average sampling rate of 200 read-outs per second. In the EXT position an external trigger source can be used to control the sample cycle. In the MAN position the sampling cycle is controlled by the inner dark portion of the dual control; the inner or TRIGGER section is a push-button switch which causes the TDVM to run through a single sampling cycle with each switch depression.
INT-EXT REF	Permits selection of an external reference source for the TDVM (EXT position), or normal use of TDVM reference source (INT position).
FULL SCALE Adjustment	Full Scale Calibration Adjustments (see Paragraph 4b, Chapter VI).
BAL-A, BAL-B	Amplifier balance controls. (See Paragraph 2b.)



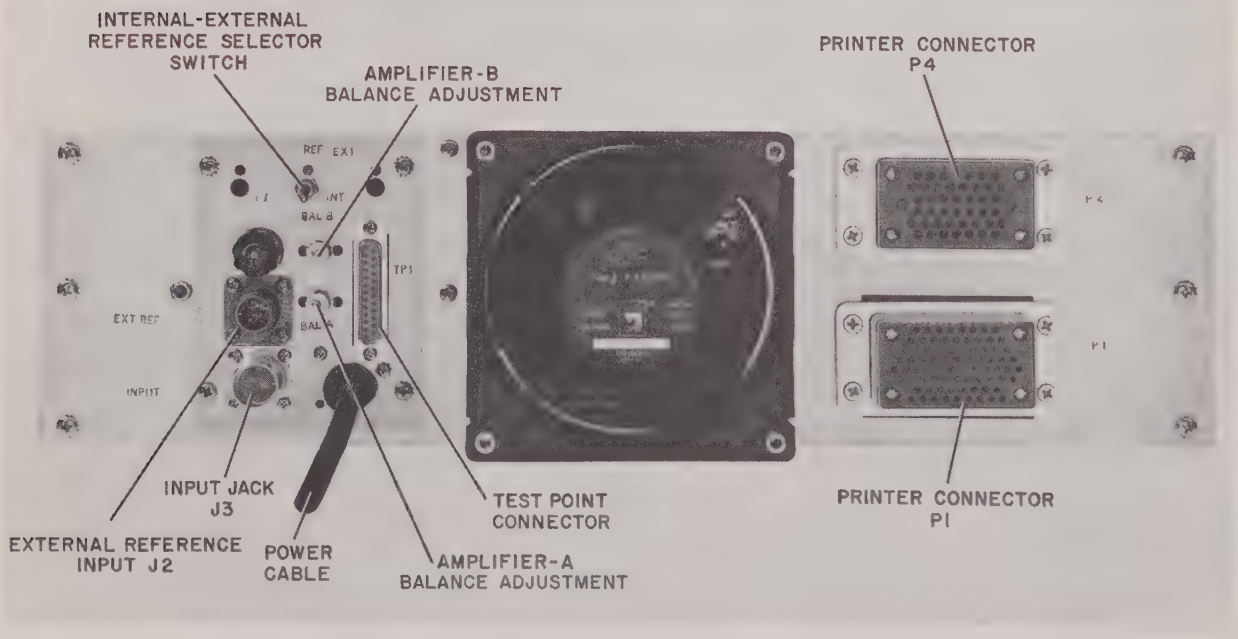


Figure 5. 5001 TDVM, Front and Rear Views Showing Controls and Connectors

2. PRE-OPERATIONAL CHECKS

The procedures outlined in this paragraph are recommended for use as a pre-operational check and for periodic preventive maintenance purposes after the instrument is in service. These checks are relatively simple to perform and serve to indicate that the instrument is functioning properly. (If trouble is encountered refer to appropriate sections of this handbook for maintenance and calibration procedures.)

a. Prepare the TDVM for operation by connecting the power cord to an appropriate a-c source. Set the power switch to STANDBY and permit the instrument to warm up for 30 minutes.

b. Connect a multimeter (Simpson, Model 260 or equivalent, set to read d-c current) between pins 16 (± ground) and 17 of the TEST POINT connector. Rotate the BAL-B potentiometer for a minimum reading.

CAUTION

Relatively high levels of current may be generated as the BAL control is rotated. Use higher current ranges first, reducing the range as the current null is approached. It should be possible to read less than 10 microamperes by careful adjustment of the control.

c. Repeat step *b.* connecting the meter between pins 16 and 18 and adjusting the BAL-A potentiometer.

d. Set the RANGE switch in the 10 volt position and rotate the ZERO control until the indicators display 00000. (If the polarity relay begins to chatter turn the ZERO control slightly *clockwise* until the chatter stops and the indicator displays 00000.)

e. Connect a low-level variable d-c voltage source (capable of supplying potentials of 0 to ±12 volts) to the input connector; set the TDVM RANGE switch to the AUTO position. *(The d-c source must be stable.)*

f. Set the d-c source for a positive output of less than 1 volt. Slowly vary the input voltage and check for proper counting sequence. Make sure that the digits in each decade are displayed in proper order and that the TDVM switches ranges when the input is raised above 1.1999 and 11.999 volts. Reverse the input polarity; observe that the polarity indicator changes.

g. Connect a high-level, variable d-c voltage source to the input connector. Alternately apply inputs of 100 and 500 (or at least 120) volts of each polarity; check for proper ranging and polarity indication.

h. Manually switch the instrument to the 10 volt range. Apply a positive or negative potential voltage of less than 10 volts to the TDVM and slowly increase this potential. Observe that the overload lamp starts to flicker as the input raises above 11.999 volts.

If the TDVM operates as described in the preceding steps and no troubles are encountered, the instrument is ready for service.

3. NORMAL OPERATION

Normal operation of the 5001 TDVM is relatively simple using the three dual front panel controls previously described. The only precaution to observe is when the TDVM range is manually selected; overload voltages of *500 volts* (or greater) applied to the instrument when on *either* the *1 or 10 volt ranges* may *permanently* damage the precision input resistor network. Since this unit is sealed, field repair is not possible and the network will have to be returned to EAI for repair or replacement.

CHAPTER IV

THEORY OF OPERATION

1. INTRODUCTION

This chapter describes the theory of operation of the TDVM in terms of a block diagram analysis, a functional diagram analysis, external control circuits, and a description of the reference and power supply circuits. These descriptions are supplemented by block diagrams, simplified schematics, a timing diagram, functional diagrams, logic diagrams, and a power distribution diagram. Transistor theory and standard circuits incorporating these devices are *not* described.

The 5001 TDVM utilizes the programmed-comparison type of meter circuit where the current produced by the unknown or input voltage is compared to a known reference current. The indicators display a voltage (in decimal equivalent) proportional to the magnitude of the reference that is required to null the unknown current.

2. BLOCK DIAGRAM ANALYSIS

Figure 6 is a simplified block diagram illustrating the operation of the 5001 TDVM. The unknown voltage is applied to the dual d-c amplifier and input circuits which provide proper scaling and isolation of the input. The scaling of the input permits the TDVM to handle the wide range of input voltages on the four range scales and maintain the required accuracy within each range. The dual d-c amplifier circuit permits selection of a positive representation of the input signal for application to the comparator amplifier summing junction regardless of the actual unknown polarity.

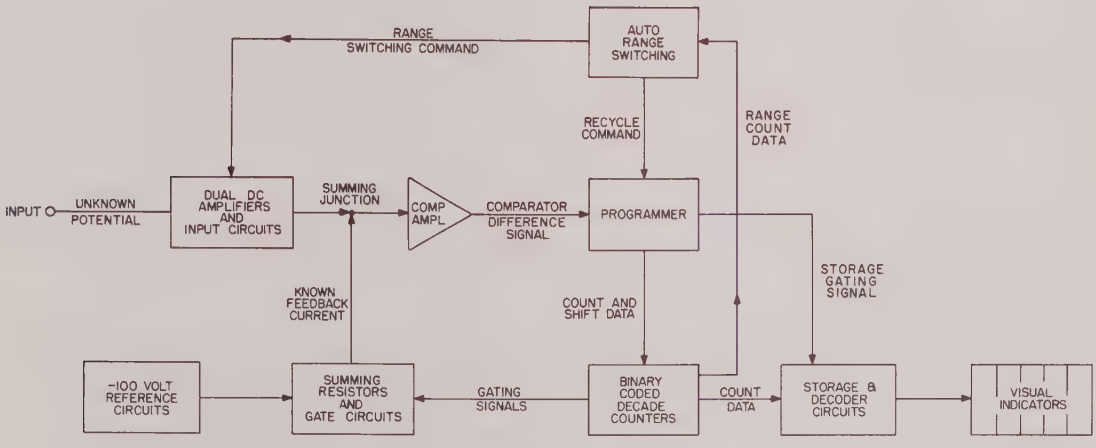


Figure 6. Simplified Block Diagram, 5001 TDVM

The positive polarity representation of the unknown is applied to the comparator amplifier summing junction where it is compared to a negative reference signal of known magnitude. The two signal currents (summed algebraically) form the input signal to the comparator amplifier. The comparator output (or difference signal) is determined by which of the two input signals at the summing junction is larger. This output does not indicate the *magnitude* of the difference but merely which is the *larger* of the two.

The comparator difference signal is sent to the programmer which in turn determines the counting instructions that are sent to the decade counters. The programmer data instructs the counters to increase or decrease the known feedback current to the summing junction based on the signal from the comparator amplifier.

In the automatic ranging mode the decade counter data is sampled by the auto range switching circuit. Dependent on the counter data the auto range circuit either permits the sampling cycle to continue (unit on proper range) or stops the cycle and up or down ranges the instrument as indicated by the count data. If range switching is required the auto range switching circuit also re-cycles the programmer so it re-starts at the beginning of the sampling cycle on the new range. In addition to its function of range switching in the automatic mode the auto range switching circuit also serves as an overload protection circuit for manual range selection. If the selected range is too low for the input voltage, the auto range switching circuit stops the sampling cycle and lights a red lamp in the extreme left-hand visual-indicator section. The instrument is momentarily switched out of the under-range setting thus protecting the precision input resistors. The instrument will return to the original range if the setting is not manually changed; however, the auto circuit instantaneously switches it out again if the overload still exists. This switching action will continue, and the red overload lamp will flicker until the unit is either up ranged (manually) to a proper setting or the over-voltage input is removed.

When the proper range is obtained the programmer is released to instruct the counters to increase or decrease the known feedback current as previously mentioned.

The counters indirectly control the feedback current by binary-coded-decimal voltage gating-signals applied to summing resistor gate circuits. The gating circuits in turn directly control the current flow from the -100 volt reference circuits to the summing junction in known binary-coded decimal steps. When the known reference current and the current due to the unknown are equal in magnitude the programmer stops the decade counter operation. The decade counters then contain, in binary-coded decimal form, the magnitude of the known current required to null the unknown current.

Storage gating instructions from the programmer (generated when the two currents are nulled) release previously stored data from the storage circuits and permit the insertion of the new binary-coded decimal count data. In addition these storage instructions hold the new data in the storage circuit thus permitting the release of the decade counters for a new sampling cycle of the input unknown.

The storage circuits apply the binary-coded data to decoder circuits which convert this data to numeric decimal notation. The numeric decimal data is applied to the indicators, illuminating the proper digits. The displayed digits are actually a scaled representation of the potential required to produce the known current, and because the known and unknown currents are equal in magnitude, it is a numeric representation of the unknown voltage *magnitude*. The indicators also display the polarity of the unknown (determined during the sign check cycle) and the decimal point location (determined by the range setting).

The entire sequence of events (polarity or sign check, magnitude evaluation and display) takes an average of 5 milliseconds when a range or polarity change is not involved. The actual time required to sample and display a given voltage may be calculated in the following manner. Assume that a clock pulse is generated by the blocking oscillator every 1/5 millisecond. It takes six of these clock-periods, regardless of the magnitude of the unknown voltage, to shift through the various counters (1000's through 1's) and to display the data. In addition it requires 1 clock-period for each digit of the magnitude from 1 to 9, plus the sign check time. As an example, if 12.48 volts (either positive or negative) is applied to the TDVM, in addition to the six required clock-periods 15 more clock-periods are required (1 clock-period for the 1 digit, 2 for the 2 digit, 4 for the 4 digit, and 8 for the 8 digit) or a total of 21 clock-periods. This total of 21 does not include that time required for the sign check; thus a total time of 4.2 milliseconds is required for the sampling cycle less the sign check time. If the signal polarity does not change, the sign check period is 1/5 millisecond and the entire operation takes 4.4 milliseconds. It takes about 25 milliseconds to operate the polarity relay (energize or de-energize); thus if there is a sign change (positive to negative input or vice versa) the operation takes about 4.2 + 25 or 29.2 milliseconds.

3. FUNCTIONAL DIAGRAM ANALYSIS

Schematic Diagram D026 158 0S, Sheet 1 through 3 (Appendix II) is a functional logic diagram of the 5001 TDVM and is used as the basis of this description. The sampling operation of the TDVM may be considered to take place in three steps: the sign check cycle, the magnitude evaluation cycle, and the storage and display cycle. The automatic range selection operation may be considered as part of the magnitude evaluation cycle. To simplify the description of the TDVM operation, however, the auto range switching circuit is described separately, as are the various special feature circuits such as the external or manual trigger circuit. This functional description is therefore divided into four separate sub-divisions. Three divisions, the sign check cycle, the magnitude evaluation cycle, and the storage and display cycle, are described assuming the instrument is in the proper range, that range switching is not required, and the instrument is set for internal triggering (free running). The fourth division describes the auto range switching circuit and its subsequent effect on the three operating steps of TDVM, should range switching be required.

For the following description assume the TDVM is properly ranged, has sampled, and is displaying a voltage value of +12.48 volts. Approximately 200 times a second the TDVM samples this applied voltage (average sampling time) thus keeping a constant check on actual voltage magnitude. After each of the sampling cycles the display is extinguished and the new sampled value displayed in its place. It takes about 1/5 millisecond to extinguish and replace the display; therefore, if the input does not vary, the display appears as if constantly illuminated.

Figure 7 is a timing diagram showing the voltage pulses at strategic points throughout the TDVM (portions of this diagram are exaggerated for clarity). The diagram is scaled across the top in intervals of time; each interval is equal to approximately 1/5 of a millisecond (0.0002 seconds). (This diagram is drawn in accordance with the assumption that range switching is not necessary.) The diagram starts at time t_0, the instant at which a new sampling cycle is started. The first step of the new sampling cycle is the sign check.

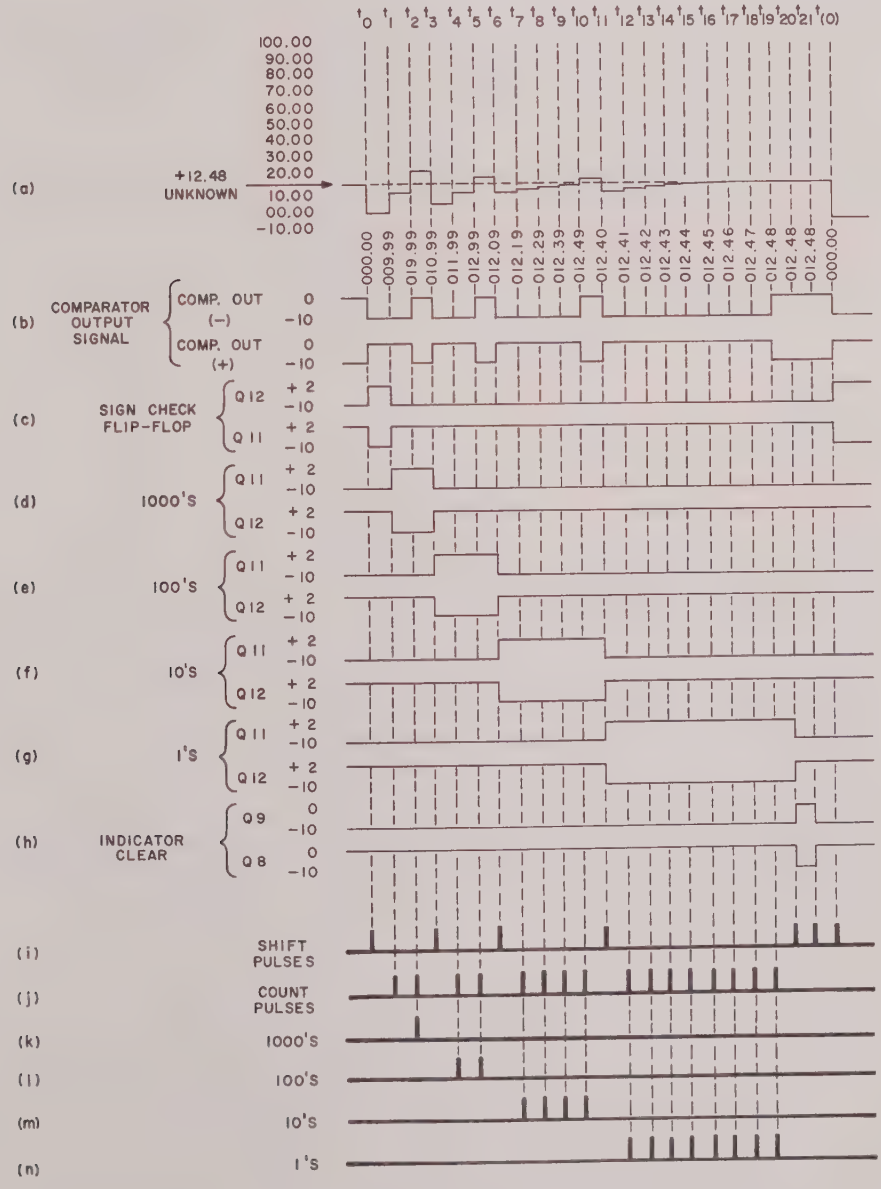


Figure 7. TDVM Timing Diagram

a. Sign Check Cycle

The TDVM is designed to function with a positive representation of the unknown input voltage applied to the comparator summing junction (regardless of the actual unknown polarity). The purpose of the sign check cycle is to assure that this condition is fulfilled before the actual sampling of the input unknown is attempted. In addition, the sign check cycle assures that the visual indicator displays the actual polarity of the unknown.

To assure the application of a positive polarity to the comparator, a relay (K1) is used at the output of the dual d-c amplifier (Figure 8). This relay permits the selection of the amplifier output from either the first section (b) or the second section (a) of the dual amplifier. If the input unknown is negative, taking the output from amplifier (b) provides the required positive representation for application to the comparator. If the unknown is positive, however, polarity relay K1 must be energized and the output of amplifier (a) used to provide the required positive representation.

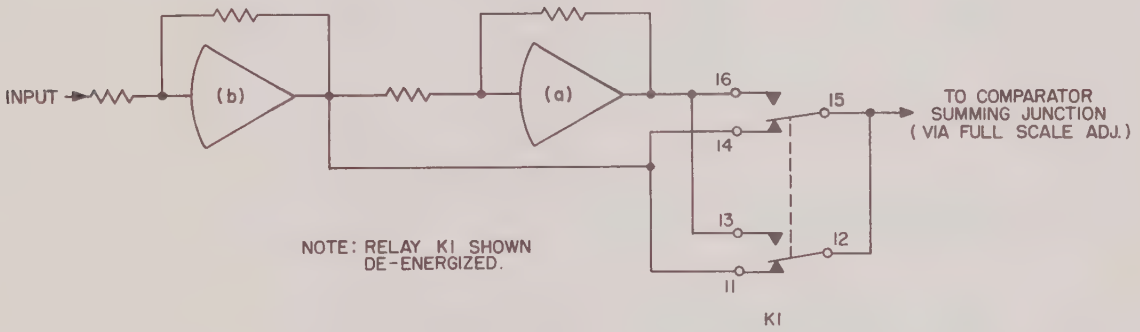


Figure 8. Dual D.C. Amplifier and Polarity Relay, Simplified Schematic

During the sign check cycle the TDVM must determine if the polarity relay, K1, is in the proper state; i.e., energized for positive unknown inputs and de-energized for negative potential unknown inputs. To determine if the relay is in the proper state the reference current is removed from the comparator summing junction so the summing junction is controlled by the unknown potential only. If the unknown representation is positive, K1 is in the proper state; if the unknown is negative, K1 must be reversed.

The sign check cycle starts at the time t_0 as shown on the timing diagram, Figure 7. At time t_0 the TDVM has completed its previous ampling operation and the unit is set to start a new sampling cycle. This new sampling operation is started (at t_0) when a clock pulse from the blocking oscillator triggers the sign check multivibrator (Q11 and Q12, Figure 9 and curve c, Figure 7). Q11 is cut off and generates a negative voltage which is routed out pin J of the programmer card to the zero-set transistor (Q10) on each of the four binary-codea decade counter (BCD) cards (D026 158 0S, Sheets 2 and 3). Q10 on each of the BCD cards sets the circuit to a zero count. Since the BCD cards control the reference current applied to the comparator summing junction (via diode gating), zero-setting the cards removes all reference current from the comparator summing junction. At time t_0, therefore, the comparator summing junction is controlled by the unknown voltage representation from the output of the dual d-c amplifier.

The comparator amplifier is a five stage transistor amplifier with outputs taken from the fourth and fifth stages (Q4 and Q5 respectively). The output at Q4 is designated *Comp Out* + and from Q5, *Comp Out* - (D026 158 0S, Sheet 1). The operation of the comparator is such that if the input is positive Q4 is saturated (collector at zero), and Q5 cut off (collector at -10 volts). A negative input reverses the situation, i.e., Q4 cut off, Q5 saturated. Thus, the *Comp Out* + lead essentally indicates the polarity of the signal applied to the comparator as follows: if the comparator input is positive the *Comp Out* + lead is at zero, if the comparator input is negative the *Comp Out* + lead is at -10 volts. The voltage on the *Comp Out* + lead between time t_0 and t_1 is used to indicate to the programmer whether or not relay K1 is in the proper state. The *Comp Out* + potential is applied to an AND circuit in the programmer (CR3 and R17) along with the negative pulse from Q11 of the sign check multivibrator (Figure 9).

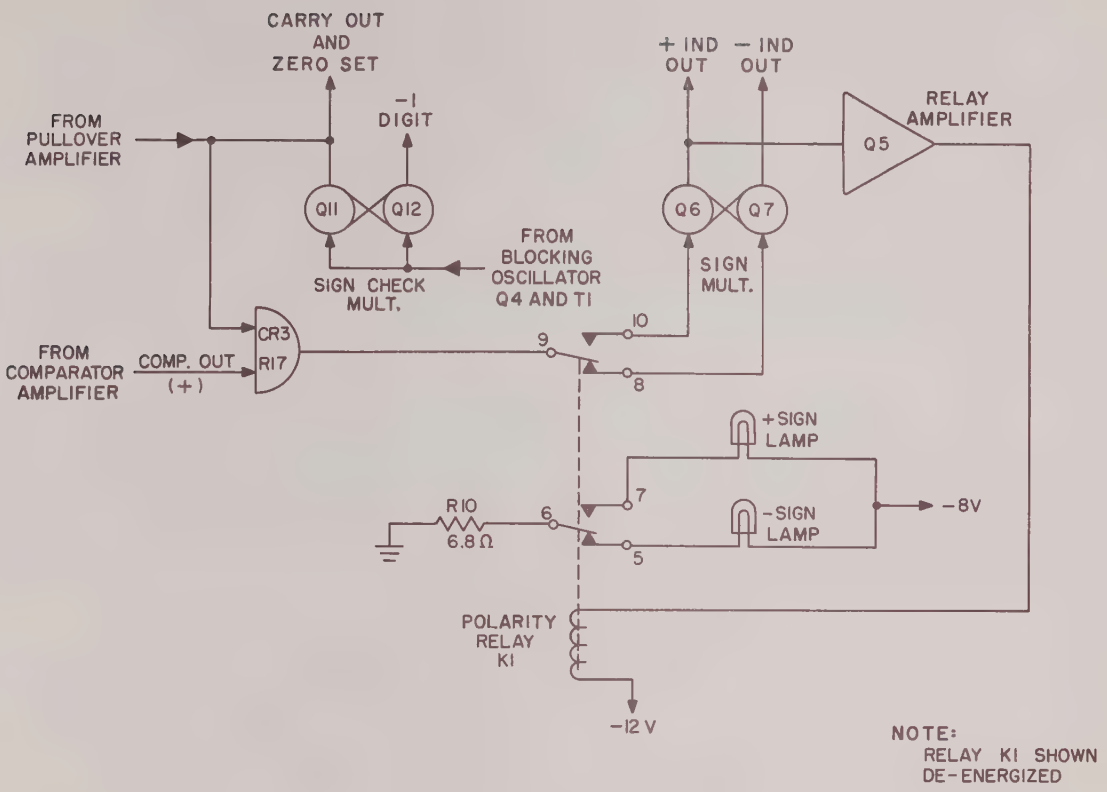


Figure 9. Sign Check Circuit, Simplified Logic Diagram

Both inputs to the AND circuit must be negative to produce an output. Since the input from the sign check multivibrator (Q11) is always negative during the sign check cycle the operation of the AND gate is controlled by the *Comp Out* + lead which is only negative when the polarity relay is in the *improper* state. Thus, during the sign check cycle, if a negative potential is applied to the comparator summing junction a pulse is passed through the CR3-R17 AND gate in the TDVM programmer. If a positive input is applied to the summing junction during this period, however, (*Comp Out* + lead at 0) no pulse will pass through the AND gate.

If a pulse passes through the AND gate it is applied to either Q6 or Q7 of the sign multivibrator depending on the state of K1. As shown in Figure 9, with K1 de-energized, the pulse is applied to Q7 triggering it into conduction. This action cuts off Q6, its collector drops to -10 volts and Q5 conducts energizing the relay. Contact K1-9 then closes with K1-10. Note that K1-9 is always connected to the side of the sign multivibrator which is cut off, i.e. K1-9 contacts K1-8 when Q7 is cut off (Q6 conducts and K1 is de-energized), K1-9 contacts K1-10 when Q6 is cut off (K1 is energized). Therefore, any time a pulse is passed through the AND gate (indicating K1 is in the wrong state) the sign multivibrator is triggered to the opposite state reversing the condition of K1.

Contacts K1-5, 6, and 7 control the polarity indicator lamps in the visual display unit. When K1 is de-energized the negative lamp lights; when K1 is energized the positive lamp lights.

The output of Q12 of the sign check multivibrator during the sign check cycle is applied to the summing junction of the comparator. This low-level signal will only effect the circuitry on a zero or extremely low-level input signals when it functions to prevent polarity-relay chattering.

As previously stated, in this description it is assumed the instrument has sampled and displayed +12.48 volts and that the sampling operation being described assumes the +12.48 volts is still applied to the instrument. Under these conditions K1 is energized and at time t_0 the proper positive representation of the unknown is applied to the

comparator summing junction. No pulse can pass through the AND gate (Comp Out + lead at 0) and the relay remains in the energized state. When a change of the relay condition is not required the sign check cycle takes approximately 1/5 millisecond to complete. A change in the relay state, however, (polarity reversal at the input), requires a minimum of 10 milliseconds. The purpose of this minimum delay is described in sub-Paragraph *d*.

At time t_1 (Figure 7) the sign check cycle is stopped (assuming K1 is not reversed) when the next blocking oscillator pulse triggers the sign check multivibrator back to its original state (Q11 conducts, Q12 cut off). At time t_1, therefore, the TDVM starts the second phase of operation, the magnitude evaluation cycle.

b. Magnitude Evaluation

Up to this point the TDVM has checked the polarity of the unknown and assured that a scaled positive representation of this potential is applied to the comparator. In addition the unit registers the polarity of the unknown on the visual readout indicators. During the magnitude evaluation phase of the sampling operation the TDVM brings the known reference current level applied to the comparator summing junction into agreement with the current due to the unknown potential.

Figure 10 illustrates how a typical BCD card controls the known reference current flow to the comparator summing junction. When a BCD registers a binary-coded 0, all of the counter multivibrators (designated 1, 2, 4, and 8 on Figure 10) are set in the *1* state, i.e., Q2, Q4, Q6, and Q8 conducting. These transistors apply a positive potential to the anodes of the diodes designated a, b, c, and d which in turn back-biases a', b', c', and d' respectively. Thus current flow through resistors 1, 2, 4, and 8 cannot pass through the back-biased diodes to the comparator summing junction. If, however, any of the counters are set in the *0* state (odd transistor conducting) the corresponding diode of the *0* state counter (a, b, c, or d) is back-biased. This removes the back-bias from the corresponding primed diode and permits current to flow from the -100 volt source, through the associated resistor, to the summing junction.

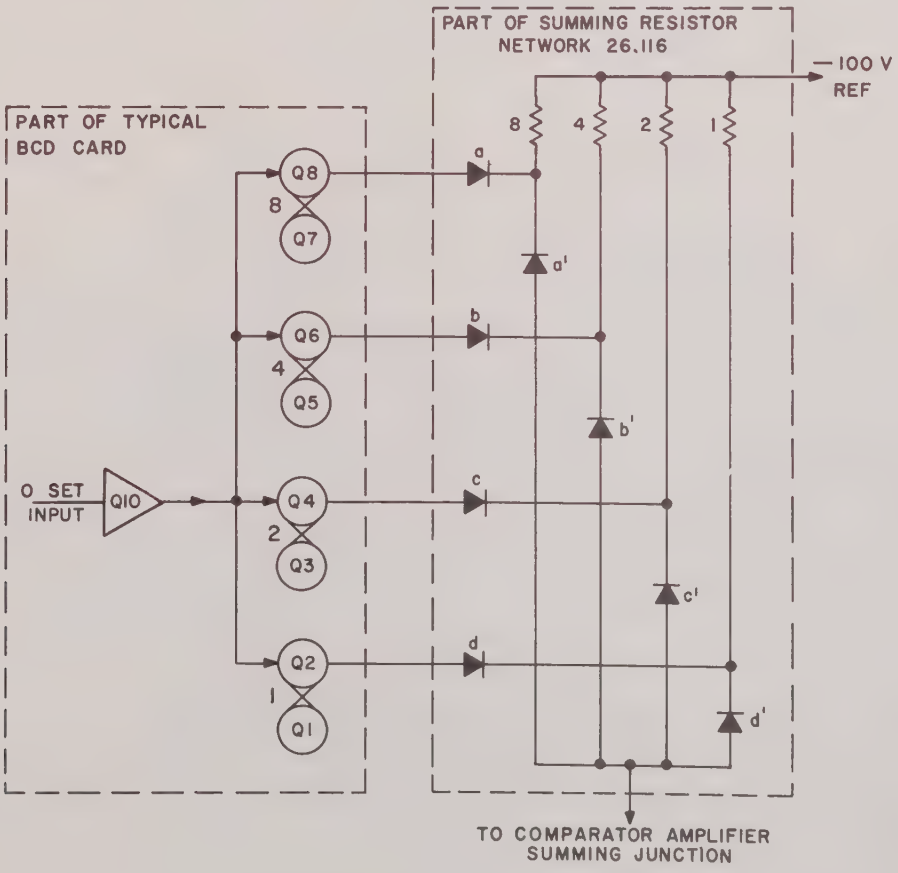


Figure 10. Typical BCD and Diode Gate Circuit, Simplified Logic Diagram

The resistors are matched such that the current flow relationship with respect to each other is in binary-coded decimal steps. Each BCD controls a set of four resistors and these sets are matched with respect to each other on decimal relationship such that the units BCD set is 10 times that of the tens set, 100 times that of the hundreds set and 1000 times that of the thousands set. This permits the counters to control the reference current flow to the comparator amplifier summing junction in four decimal groups of binary-coded decimal steps of known magnitude. When the known current is in agreement with the unknown (in magnitude), the magnitude of the unknown is recorded in the BCD count.

Figure 10 also shows the 0-set transistor Q10; at time t_0 when Q11 of the sign check multivibrator triggers this circuit the BCD card is set to a zero count. Each BCD contains a 0-set circuit; thus, at time t_0 all reference current is removed from the comparator summing junction.

At time t_1 the magnitude evaluation starts when the sign check multivibrator reverses its state (due to a pulse from the blocking oscillator). The collector of Q11 (of the sign check multivibrator) goes slightly positive; this positive potential reverses the state of the 1000's multivibrator (Q11 and Q12) on the 1000's binary-coded decimal counter. (D026 158 0S, Sheet 3.)

In reversing the state of the 1000's multivibrator (Figure 7) a positive potential is applied to the anode of diode CR21 (Figure 11). This biases CR21 so the count pulses (added to this bias voltage) are sufficient to trigger the 1's counter multivibrator (Q1 and Q2). If Q11 is cut off and a negative potential is applied to the anode of CR21 the count pulses at this time are not of sufficient magnitude to trigger the counters.

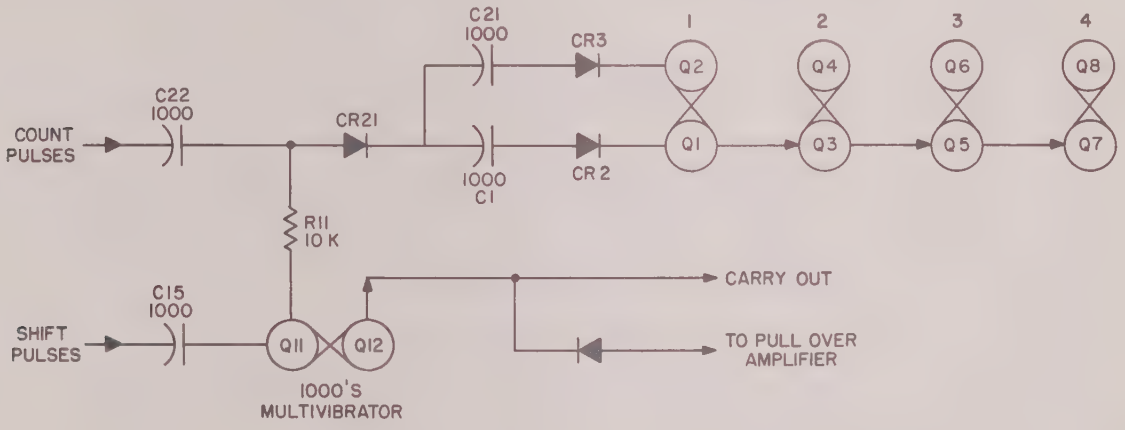


Figure 11. Typical BCD Count and Release Circuit, Simplified Logic Diagram

At time t_1 only Q11 of the 1000's multivibrator is set to the proper state; thus, only the 1000's decade counter can react to the count pulses. The negative pulse generated by Q12 at this time is applied to the 9-set transistors (Q9) of the 100's, 10's, and 1's counter (D026 158 0S, Sheet 3). The 100's, 10's, and 1's decade counter cards are each set to a nine count (Q2 and Q8 cut off) permitting current representing a 999 count to flow to the summing junction from the reference source. This is equivalent to applying current from a -9.99 volt source to the summing junction when the meter is on the 100 volt range (as is necessary to measure +12.48 volts).

In addition to 9-setting the remaining counters, the negative potential from the collector of Q12 (of the 1000's multivibrator) is applied through diode CR14 to the base of the pullover inverter (Q10) on the programmer card. The pullover inverter *locks the sign check multivibrator* (Q11 conducting, Q12 cut off) *preventing it from being triggered during the evaluation cycle.*

At time t_1 to t_2 current at the summing junction of the comparator amplifier is controlled by two voltage sources: the scaled positive representation of the unknown input (+12.48 volts) and the scaled equivalent of -9.99 volts from the negative reference source. Between times t_1 and t_2, therefore, the positive unknown potential, being larger, controls the comparator summing junction current, and Q1 of the comparator is cut off. This causes the *Comp Out* + line to be at ground potential and the *Comp Out* - line to be at -10 volts.

The *Comp Out* + and *Comp Out* - leads are connected to Q1 and Q2 of a double AND gate (D026 158 0S, Sheet 2). Pulses from the blocking oscillator are continually applied to both of these transistors via emitter follower Q3. Q3 functions to isolate the blocking oscillator to prevent loading that circuit.

Either Q1 or Q2 passes the blocking oscillator pulses if the corresponding *Comp Out* lead connected to that transistor is negative. At time t_2 the *Comp Out* - lead is negative; thus Q2 passes the blocking oscillator pulse. The output of Q2 forms the count pulses and these are sent to all of the binary-coded decade counters. The 1000's counter is the only unit released for counting at time t_2; therefore, it registers a *1* count. This increases the known current flow to the summing junction to a value equivalent to -19.99 volts. At time t_2 then, the known current becomes larger than the unknown (+12.48 volts). The comparator summing junction comes under the control of the negative current source and the Comp Out + line goes to -10 volts. *

The -10 volts on the *Comp Out* + lead permits the blocking oscillator pulse at time t_3 to pass through Q1 of the double AND circuit. This is the TDVM *shift* pulse. The *shift* pulse (a positive pulse) is applied to Q11 of the 1000's, 100's, 10's, and 1's multivibrators (D026 158 0S, Sheet 3 and Figure 11). Q11 of each multivibrator is cut off in each case, with the exception of the 1000's multivibrators. The *shift* pulse only effects the 1000's multivibrator and triggers this circuit to its opposite state (Q11 cut off, Q12 conducting). As Q12 conducts, the collector voltage goes in a positive direction; the positive voltage is applied to Q12 of the 100's multivibrator triggering this circuit to its opposite state.

Triggering the 100's multivibrator releases the 100's counter for counting. In addition the negative-going voltage of Q12 of the 100's multivibrator (curve *e* of Figure 7) is applied to the 100's zero-set transistor (Q10) setting the 100's counter to zero. This changes the apparent negative potential applied to the comparator summing junction from -19.99 volts to -10.99 volts. The current due to the +12.48 volt representation of the unknown regains control of the summing junction. The *Comp Out* - lead becomes -10 volts and the next blocking oscillator pulse generates a *count* pulse.

The negative potential from the collector of Q12 (100's multivibrator) is applied to the base of the pullover inverter. Thus, even through Q12 of the 1000's counter is conducting, the negative potential from Q12 of the 100's counter prevents the sign check multivibrator from being triggered.

At time t_4 the blocking oscillator pulse is passed through Q2 of the double AND circuit and sets the 100's counter to one. The known current at the summing junction becomes equivalent to -11.99 volts. The unknown voltage representation (+12.48 volts) is still larger however; thus at time t_5 a second count pulse is generated. The 100's counter is set to a two-count (curve 1, Figure 7) and the negative or known voltage equivalent becomes -12.99 volts. With the known current controlling the summing junction a shift pulse is generated at time t_6. The shift pulse sets the 10's counter for counting and locks the 100's counter.

The counting process continues in a similar manner as until time t_{19} when the known and unknown current are in agreement (in magnitude). At this time the summing junction goes under control of the negative potential of the zero set potentiometer R2. The *Comp Out* + lead is therefore at -10 volts at time t_{20} and a shift pulse is sent from the programmer. This shift pulse reverses the state of the 1's multivibrator, stopping the counting cycle and starting the conversion and display cycle.

c. Conversion and Display Cycle

Up to time t_{20} the TDVM has checked the polarity of the unknown, illuminated the proper visual readout sign indicator and brought the reference feedback current magnitude into agreement with the unknown current magnitude. Since the magnitude of the reference current is controlled by the BCD cards, the BCD count must also be an indication of the unknown input magnitude. During the conversion and display cycle the BCD count is transferred to the readout storage decade (RSD) cards for storage and conversion to arabic decimal for display on the visual readout. Storage of the BCD count in the RSD cards permits clearing (or zero-setting) the BCD card so a new sampling operation can be made while the previously attained value is held and displayed.

As previously stated the conversion and display cycle starts at t_{20} when a shift pulse from the programmer reverses the state of the 1's multivibrator (curve *g*. Figure 7). The positive collector voltage of Q12 of the 1's multivibrator is applied to Q8 of the indicator clear multivibrator on the programmer card cutting it off and appling its negative collector potential to the pullover inverter, maintaining it in the conducting state; thus the sign check multivibrator is held in the locked condition.

**Although the Comp Out + lead is at -10 volts this does not affect the sign multivibrator because the sign check multivibrator is locked by the pullover inverter.*

The positive collector voltage of Q9 of the indicator clear multivibrator is the actual clearing signal. This signal is applied to the indicator clear gate Q3 (on the Network Card, C012 687 0S) cutting it off (Figure 12). Transistor Q3 in its normally conducting state forward-biases the gating diodes on the RSD cards (CR5, 13, 14, 21, 22, 29, 30, and 36 on Figure 12 and Schematic Diagram D051 010 0S).*

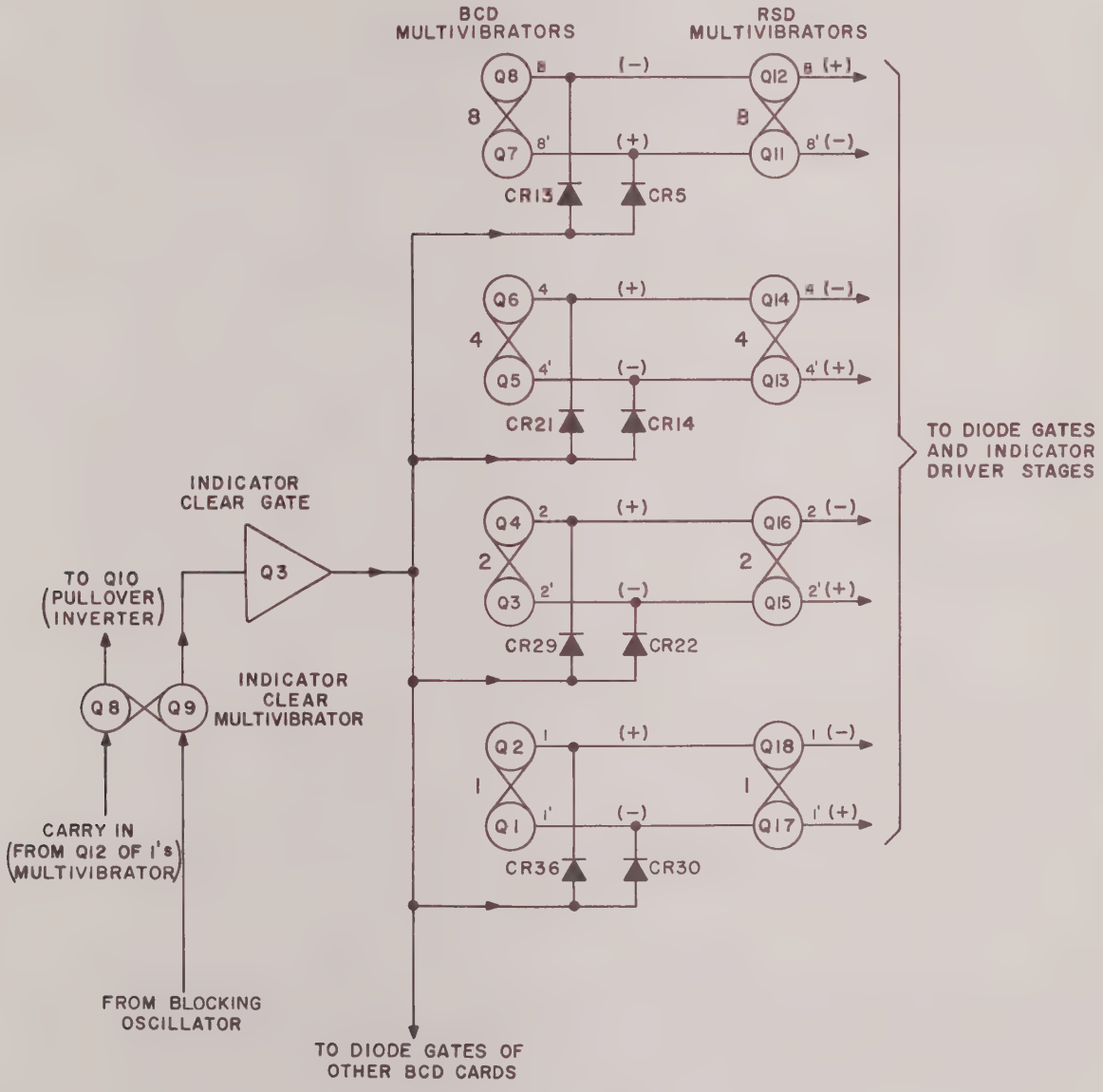


Figure 12. Typical Indicator-Clear Gating Circuit, Simplified Logic Diagram

Due to the similarity of operation between the 51.080 and 51.010-1 Models of the RSD card only the operation of the 51.010-1 is used in this description.

The forward biased diodes prevent the operation of the BCD cards from affecting the RSD multivibrators during the sampling operation. At time t_{20} when Q3 is cut off (reverse biasing the diode) the state of the BCD counters triggers the corresponding RSD multivibrators in a similar but opposite state. As an example, Figure 12 shows the collector voltages of the BCD and RSD multivibrators in parenthetical notations (where + = 0 volts and - = -10 volts) for a binary-coded eight. Note that the collectors of the RSD multivibrators are opposite to those of the BCD counters.

At time t_{21} the blocking oscillator triggers the indicator clear multivibrator back to its original state (Q8 conducting, Q9 cut off). This permits the indicator clear gate Q3 to conduct and locks the RSD multivibrators with the new count so subsequent action of the BCD counters can not effect them. At the same time the pullover inverter is released; thus, at time t_{22}, shown as $t_{(0)}$ on Figure 7, the sign check indicator is released so the blocking oscillator pulse can zero-set the counters and the TDVM can start a new sampling operation.

Figure 13 is a logic diagram illustrating the conversions of the binary-coded decimal data to arabic decimal. Following through with the binary 8 used in Figure 12 the plus and minus parenthetical notations in Figure 13 indicate 0 and -10 volts respectively.

The AND gates shown in Figure 13 correspond to the diodes of Schematic Diagram D051 010 0S. Note on the schematic that the base of each of the drivers (Q1 through Q10) is connected to the -8 volt supply and will conduct *unless* one or more of the diodes is forward biased. Thus for a driver to conduct and illuminate its corresponding digit lamp each diode of its base AND circuit must be reverse biased; i.e., for the 8 digit to light (Q9 conducting) the 8' and 1 inputs to the Q9 AND circuit of Figure 13 *must both be negative* and at least *one* of the inputs to all the other AND circuits must be *positive*. Studying the parenthetical notations of Figure 13 shows that this is true. (Note that because of the previously mentioned reversal of collector potentials between the BCD counters and the RSD multivibrators that the 1, 2, 4, and 8 outputs are used instead of the 1', 2', 4', and 8' to indicate a zero, and similarly 8' and 1 indicate an 8.)

Figure 14 is a simplified logic diagram for the 51.080 RSD card. This card is essentially a modification of the 51.010 Card; the modification permits the card to store and read out the additional 10,000's count necessitated by the 20 percent overrange capabilities of the instrument. Note the similarity in logic between Figures 13 and 14; differences in logic are directly related to the overrange capability. As an example, the 9-driver AND circuit of the 51.080 RSD uses the *2* intelligence in addition to the 8' and 1' as used by the 9-driver AND circuit of the 51.010 RSD. The additional *2* prevents the 51.080 9-Driver from conducting when an eleven count is registered. The 0 and 1-driver inputs are extensively modified on the 51.080 RSD due to the necessity of Q11 being required to conduct on both a 0 and 10 count and the Q12 requirement for both a 1 and 11 count.

In the case of an increasing gradient voltage where the ramp is extremely steep, or a voltage in which there is a sudden rise in magnitude, it is possible for the voltage to rise above the sampling point before the magnitude evaluation is complete. As an example, assume that the meter starts a sampling cycle when the unknown is equal to 12.00 volts in magnitude. Assume that a sudden rise in potential places the input magnitude at 13.00 volts at the instant that the 10's counter starts its count cycle. This means that at the instant the unknown is at 13 volts a reference current equal to 12.09 volts appears at the summing junction. The 1000's and 100's counters are locked and cannot increase their count; thus, even if the 10's counter counts to its maximum (9 count), the reference current (equal to 12.99 volts) is not sufficient to control the comparator summing junction and cause a shift pulse; thus the counters would stop cycling. To prevent this situation, two diodes (CR17 and CR18 in the 44.139-1 Units) are connected in parallel between the 1 and 8-count output leads of the BCD flip-flops and the base of Q12 of the corresponding 100's, 10's, or 1's multivibrator. Thus as a counter reaches 9, it automatically shifts to the next counter due to a positive pulse through CR17 and CR18, and the sampling cycle is completed. A similar circuit is provided in the 1000's BCD (44.139-5 Unit) except the automatic shift (provided by CR17 and CR201) takes place on a 12 count. (It should be noted that the digital information obtained at the end of a sampling cycle will always represent the magnitude of the signal voltage at some point during the cycle, even though the input was changing rapidly.)

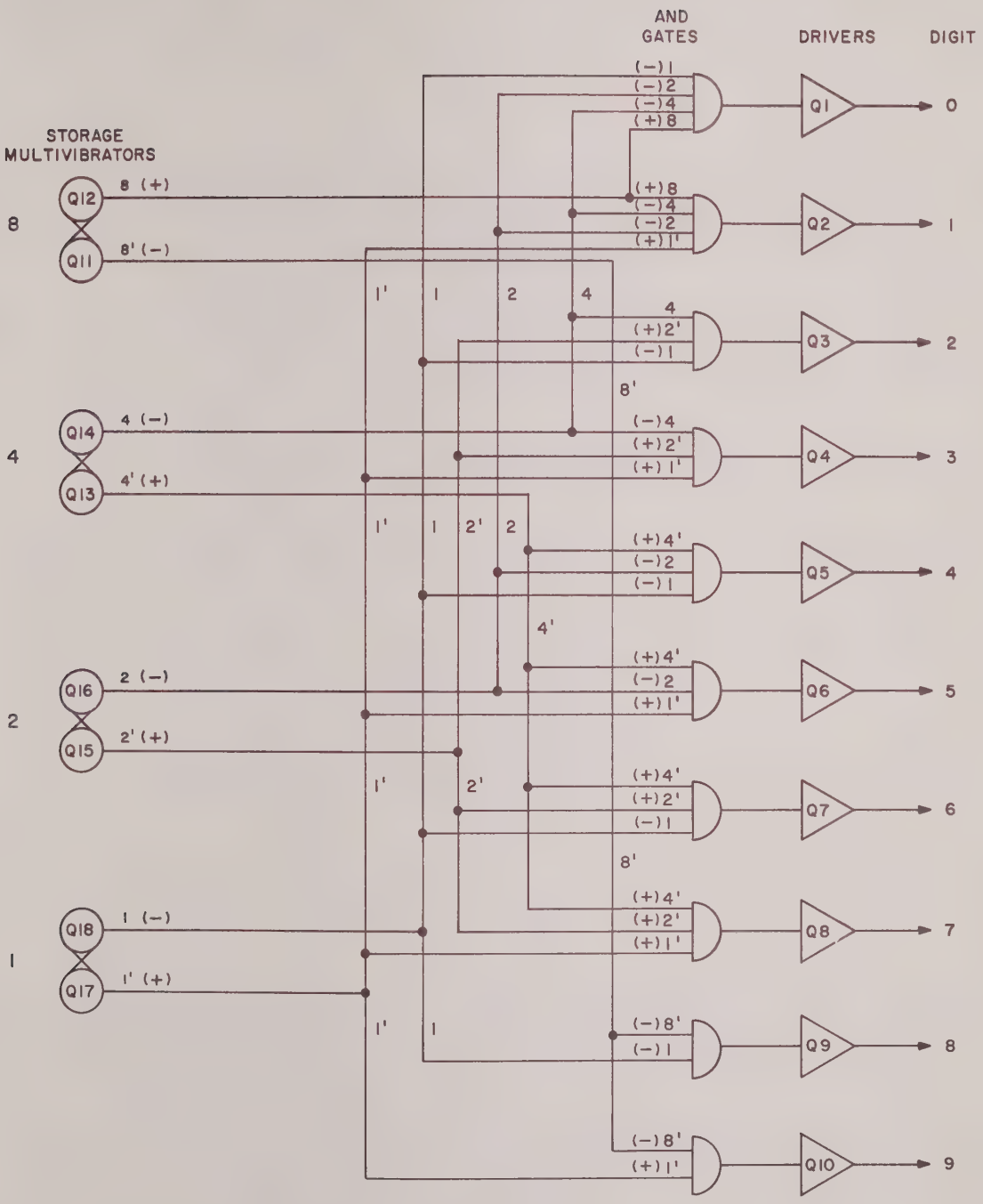


Figure 13. Typical 51.010-1 RSD Binary-to-Decimal Decoding, Simplified Logic Diagram

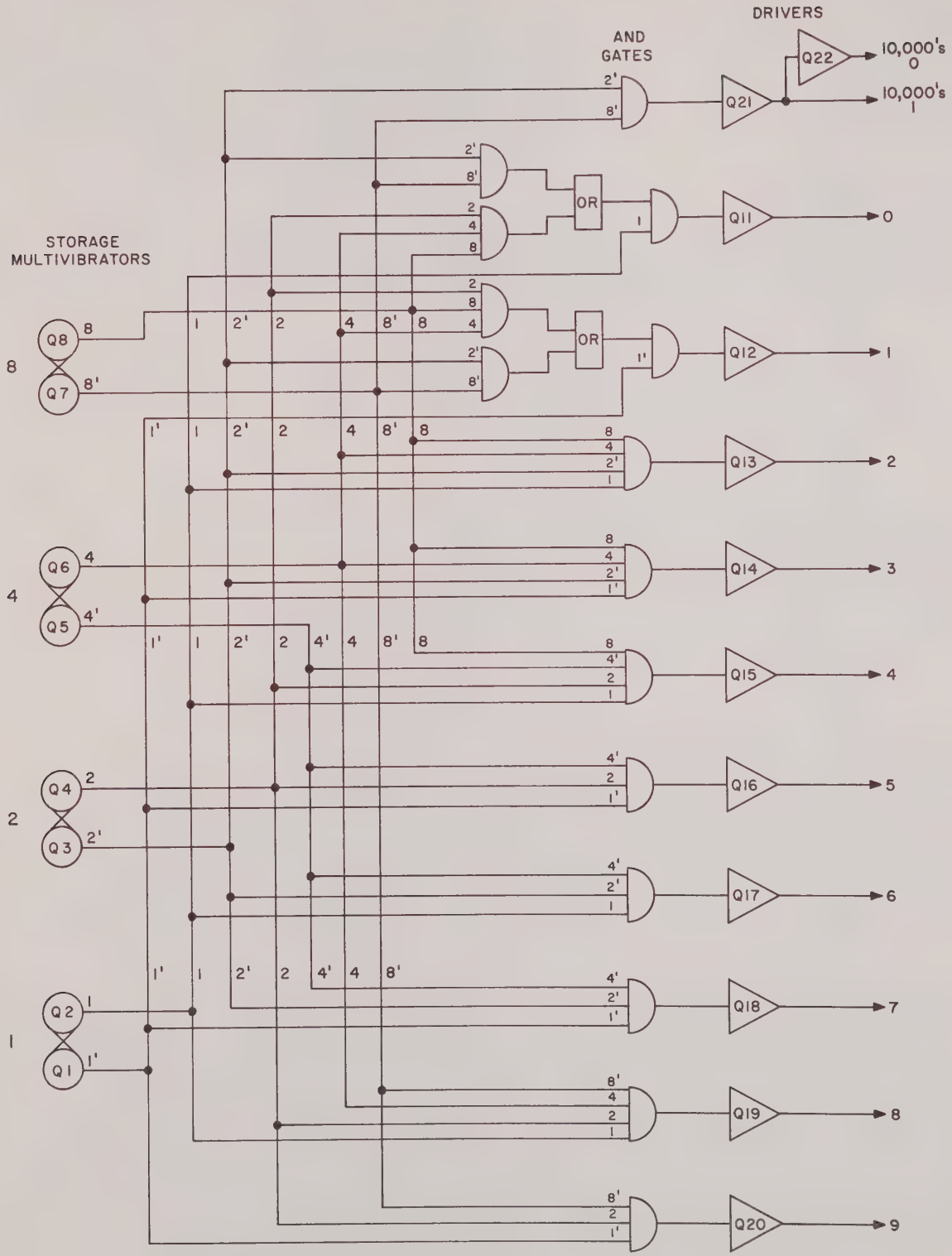


Figure 14. RSD 51.080-1 Binary-to-Decimal Decoding, Simplified Logic Diagram

The following table briefly summerizes the TDVM operation as described in detail in the preceding paragraphs. The summary is given with respect to the time increments of Figure 7. (This table, as in the preceding text, assumes a +12.48 volt input.)

TIME	OPERATION
0	Sign Check Multivibrator triggered; sets decade counters to zero and checks relay K1 to ascertain that it is in the proper state. (In addition a small positive potential is applied to the comparator summing junction to prevent possible relay chatter on low-level input signals.)
1	Sign Check Multivibrator state reversed: 1000's multivibrator triggered, releasing 1000's counter; 100's, 10's, and 1's counters 9-set. Reference current proportional to -09.99 volts applied to summing junction.
2	Reference current *smaller* than unknown: 1000's counter counts to one. Reference current now proportional to -19.99 volts.
3	Reference current *larger* than unknown: shift pulse reverses 1000's multivibrator (locking 1000's counter) which in turn triggers 100's multivibrator. 100's multivibrator in operating zero-sets 100's counter. Reference current now proportional to -10.99 volts.
4 through 19	During this time period the counting cycle continues through the 100's, 10's, and 1's counters until the reference current is proportional to -12.48 volts (equal in magnitude to the input unknown).
20	Reference and unknown *equal* in magnitude: shift pulse clamps units multivibrator which in turn triggers indicator clear multivibrator. Decade counter data transferred to storage cards for conversion and display.
21	Indicator clear multivibrator reversed: data clamped in storage circuits; pullover inverter cut off thus releasing sign check multivibrator. The next blocking oscillator pulse triggers sign check multivibrator and starts new sampling cycle.
22 (0)	Sign Check Multivibrator triggered; new sample operation started.

d. Automatic Range Selection

The automatic range switching circuit performs two separate functions depending on the operating mode of the TDVM (automatic or manual range selection). In the automatic range selection mode (selected either locally or remotely) the circuit seeks and selects the lowest possible range capable of measuring a given input voltage (up to 20 per cent overload of a range). When a range is selected manually the circuit acts as an overload protection circuit to prevent damage of the precision input circuitry.

This description assumes the instrument is in the automatic range selection mode; however, a description of circuit action when the instrument is in either the manual or remote modes is also given. The Automatic Range Switching Circuit 14.115 (Schematic D014 115 0S) essentially consists of two parts (down range and up range circuits); for clarity, these circuits are described separately.

Figure 15 is a simplified logic diagram of the down-range portion of the 14.115 Unit (portions of this circuit are common to the up-range circuit). The state of relays K2 and K3 determines the gain of the input dual d-c amplifier circuit and thus the range of the TDVM. Figure 16a is a simplified schematic of the dual d-c amplifier circuit showing relays K2 and K3. Figures 16b through e are simplified schematics showing the feedback circuit of the d-c amplifiers in each of the four ranges as a resultant of the operation of the two relays.

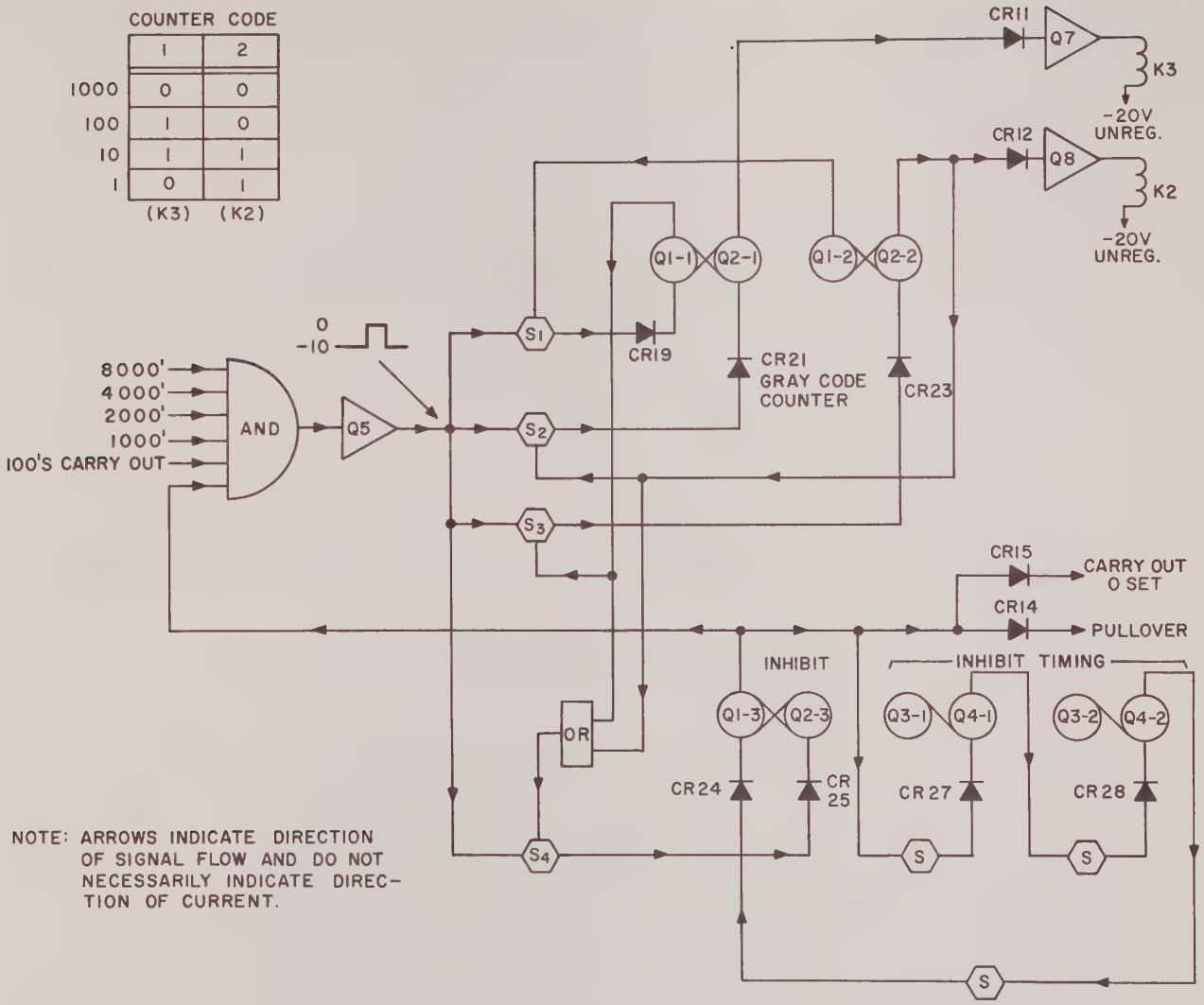


Figure 15. Down Range Circuit, Simplified Logic Diagram

Relays K2 and K3 (Figure 15) function in response to the gray-code counters consisting of multivibrator-1 (Q1-1 and Q2-1) and multivibrator-2 (Q1-2 and Q2-2). Multivibrator-1 controls relay K3 and multivibrator-2 controls relay K2; when either of the multivibrators is in the 1 state (right-hand transistor cut-off, left-hand transistor conducting) its corresponding relay is energized. The table in Figure 15 lists the state of each multivibrator on the four ranges of the TDVM; the parenthetical notation under each column designates the relay controlled by that portion of the counter. To change ranges, therefore, it is necessary to change the status of the counter circuit. Note, however, that the TDVM will only down range one step at a time, i.e., if the proper scale is the 1 volt range and the instrument is on the 100 volt range, it will first step to the 10 volt range and then the 1 volt range.

The AND circuit on Figure 15 indicates if down ranging is required by sampling the output of the 1000's BCD counters and the 100's carry out voltage. If the 1', 2', 4' and 8' outputs are all negative this indicates a zero in the 1000's BCD. This information alone, however, is not sufficient since this condition also exists during the sign check cycle. Therefore an additional bit, the 100's carry out, indicates to the AND circuit that not only is the 1000's count zero but that the 100's counter has been released for counting and the 1000's zero is a result of magnitude evaluation, and not sign check. The zero in the 1000's counter at his time indicates the TDVM is on too high a range. The final input indicates to the AND circuit whether or not the TDVM is already in a range change cycle; this circuit is described later in the text.

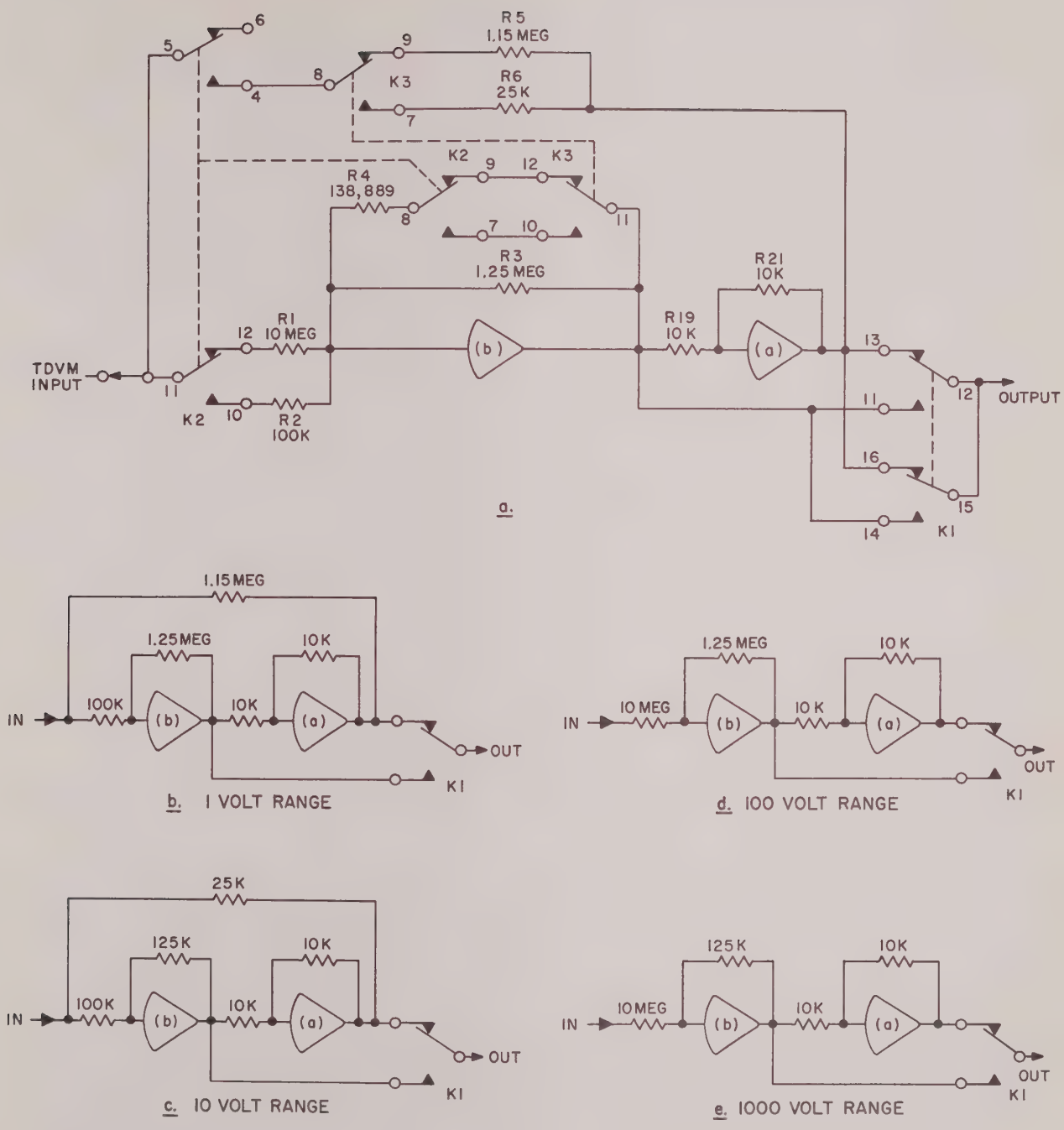


Figure 16. Dual D.C. Amplifier, Simplified Schematic Diagrams

Assuming that the 1000's counter is at zero, the 100's counter is open for counting, and the TDVM is not in the process of down ranging, the AND circuit (because of all negative inputs) saturates amplifier Q5. This generates a positive potential that is applied to the gated differentiators S_1 through S_4. The pulse from Q5 contains only the intelligence that the TDVM must be down-ranged; thus, by gating the differentiators as to which range the TDVM is on, the pulse is guided through the proper differentiators to down-range the TDVM to the next lowest range.

Table V lists by range the state of the collectors of each transistor in the counter, and the differentiators that are released.

TABLE V. Differentiator Gating Sequence

RANGE	GRAY CODE		MULTIVIBRATOR-1		MULTIVIBRATOR-2		RELEASED DIFFERENTIATOR
	MULT-1	MULT-2	Q1-1	Q2-1	Q1-2	Q2-2	
1000	0	0	-10	+2	-10	+2	S_2 & S_4
100	1	0	+2	-10	-10	+2	S_3 & S_4 (S_2)
10	1	1	+2	-10	+2	-10	S_1 & S_4 (S_3)
1	0	1	10	+2	+2	-10	(S_1)

Comparing the table with Figure 15 the function of each gated differentiator may be derived as follows: a pulse through S_1 sets multivibrator-1 in the 0 state; a pulse through S_2 sets multivibrator-1 in the 1 state; a pulse through S_3 sets multivibrator-2 in the 1 state; and a pulse through S_4 triggers the inhibit multivibrator.

Under the released-differentiator column of the table (in the 100, 10, and 1 volt ranges) are differentiator designations in parentheses; these differentiators although released, do not function in the actual down-range operation. In being released however, they do prevent possible false triggering of one multivibrator (via transient pulses) when the other multivibrator is triggered.

As previously mentioned, a pulse through S_4 triggers the inhibit multivibrator (Q1-3 conducts, Q2-3 cut off). The collector voltage of Q1-3 (at +2 volts) performs four functions: (1) it locks the AND gate thus indicating a down-range step is in process (Q5 is cut off); (2) a positive level is set out on the *carry out - zero set* lead resetting the BCD to zero and inhibiting the sign check FF thus preventing the start of a digitizing cycle during range switching; (3) a positive level is applied to the pullover line to prevent the indicator clear multivibrator from giving an indicator-clear signal; and (4) Q4-1 of the inhibit timing multivibrators is cut off.

The inhibit timing multivibrators (both are monostable) time the operation of the inhibit gate operation; due to the long duty cycle, two monostable multivibrators are used. When Q4-1 is cut off, approximately 50 milliseconds later it returns to its original state and triggers Q4-2. Again there is approximately a 50 millisecond delay and Q4-2 returns to its original state (conducting). Thus, after a delay of approximately 100 milliseconds, the positive collector potential of Q4-2 triggers the inhibit multivibrator by cutting off Q1-3. This removes the pullover voltage, the carry out 0-set signal and the positive potential from the AND gate lead. During the 100 millisecond delay, however, the TDVM gray-code counter has down ranged the instrument.

During the new conversion cycle, if the 1000's counter again registers a zero count the down-range procedure as described previously is repeated. Note that if the instrument is on the 1 volt range and a zero is read into the 1000's counter, that the only differentiator open is S_1; this has no effect since the multivibrator-1 is already in the 0 state. S_4 is not released so the inhibit gate is not triggered; the magnitude evaluation continues and the 1000's zero is displayed by the visual indicator.

When the instrument range is set manually, ground is removed from the emitter of Q5; thus, even though a pulse is passed by the AND gate, Q5 can not conduct and down-ranging is not initiated.

Figure 17 is a simplified logic diagram of the up-range portion of the 14.115 Unit. The necessity of up-ranging is indicated when the 1000's BCD records a 12 count. (With the 20% over-range capability of the TDVM the last visual indication on the readout system is 11.999; thus, a 12 in the 1000's counter indicates an overload.) As previously mentioned when the 1000's BCD reaches a 12 count, diodes CR17 and CR201 (Schematic Diagram D026 158 0S, Sheet 3) automatically shift the count to the 100's counter. At this time an up-range is indicated via the AND gate (Figure 17) if Q1-3 of the inhibit gate does not indicate that up-range switching action is already in process. From this point the action of the circuit is similar to that as described for the down range switching with the exception that the gray code counter is triggered to place the TDVM in the 1000 volt range. Thus despite what range the instrument is on, *the up-range circuit always sets the TDVM in the 1000 volt range,* and then, if necessary, the down range circuit seeks a lower range (if indicated by the input magnitude). For example, if the TDVM is on the 10 volt range and 100 volts is applied, the up-range circuit sets the instrument to the 1000's volt range and then the down range circuit will set the instrument in the 100 volt range. This feature assures a minimum duty cycle for the 100,000 ohm input resistor of the 1 and 10 volt range whenever an overload is indicated.

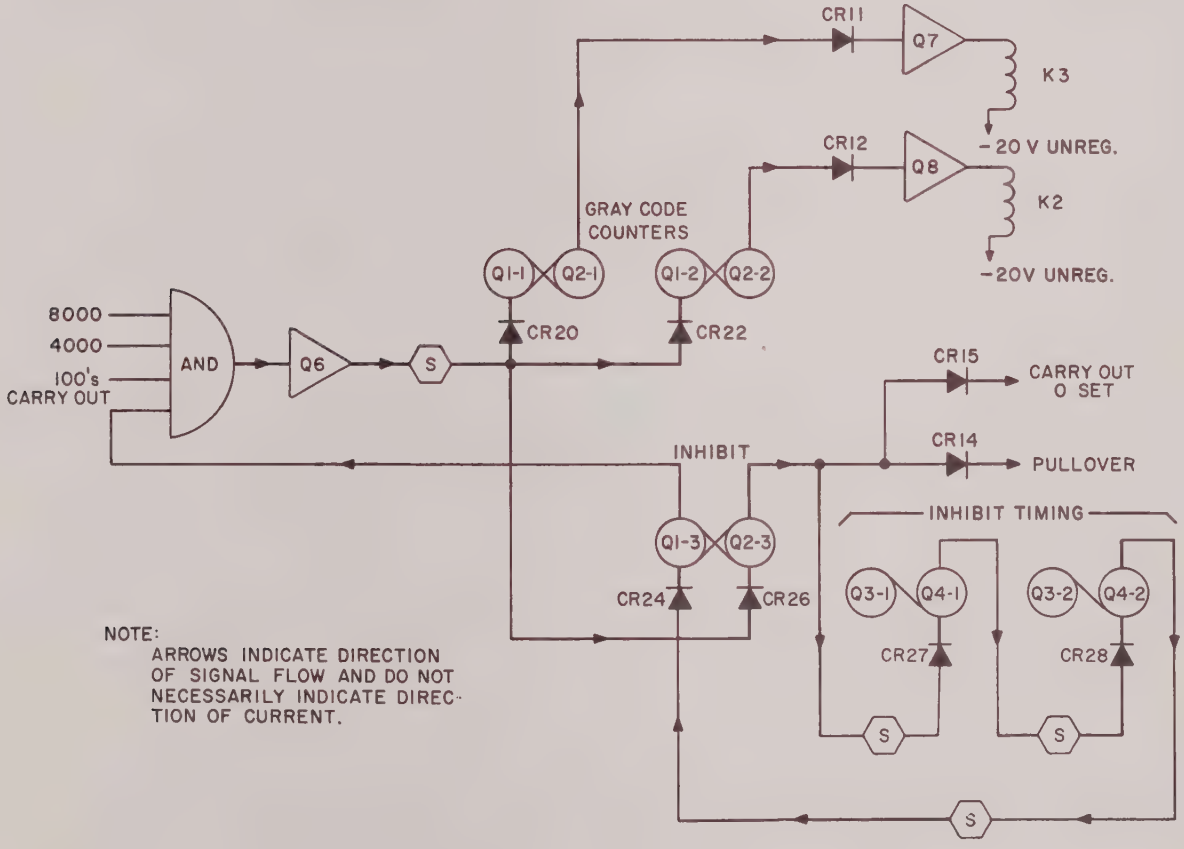


Figure 17. Up Range Circuit, Simplified Logic Diagram

The functions of the inhibit multivibrator and the inhibit timing multivibrators are identical to those described in the down-range sequence. The major difference between the down-range circuit and the up-range circuit functions is that during manual range selection the up-range circuit is still active. Thus, the up-range circuit acts as an overload protection circuit for manual range selection.

The function of the overload circuit is primarily to protect the 100,000 ohm input resistor on the 1 and 10 volt ranges. The 10 megohm resistor of the 100 and 1000 volt ranges can handle up to 500 volts continuous overload (and higher potentials for a short duty cycle) when the instrument is in the 100 volt range. For these reasons

the overload circuit controls only relay K2, de-energizing this relay when an overload is applied. The effect of controlling K2 is as follows: (1) if the TDVM is on the 100 volt range the instrument remains in this range but an overload lamp is lit; (2) if the TDVM is on the 10 volt range K2 is de-energized (TDVM reverts temporarily to the 100 volt range) and the overload lamp lights; (3) if the TDVM is on the 1 volt range K2 is de-energized (TDVM set temporarily to 1000 volt range) and the overload lamp lights. The TDVM remains in the temporary range for the 100 millisecond duty cycle of the inhibit multivibrator. As the inhibit multivibrator resets the TDVM will revert to the original manually selected range if the RANGE switch is not manually changed; however, after approximately 2 to 3 milliseconds the protection circuit will again place the instrument in the temporary higher range setting. The 2 to 3 millisecond overload when compared to the 100 millisecond period is sufficiently short for protection of the 100,000 ohm input resistor.

Figure 18 is a simplified diagram of the overload protection circuit. If an overload exists, thus triggering the inhibit multivibrator, Q9 is cut off (de-energizing K2, if energized) and Q10 conducts illuminating the overload lamp. The magnitude evaluation cycle is stopped (via CR14 and CR15) as previously described. The overload lamp shows up as a red spot on the left-hand side of the visual indicator thus signaling the operator to select a higher range*.

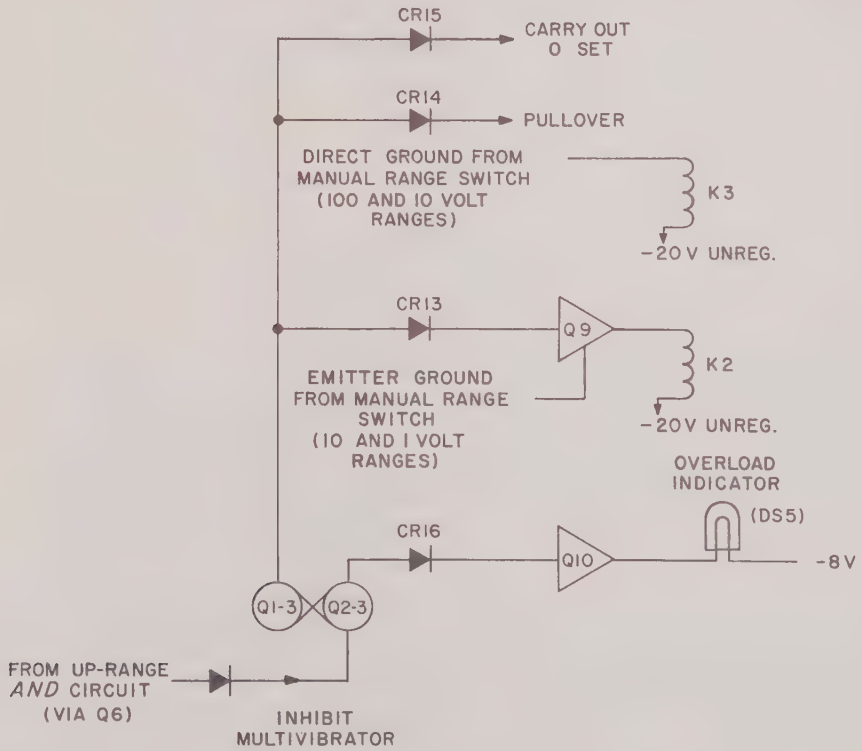


Figure 18. Manual Range Overload Protection Circuit, Simplified Logic Diagram

A 25 millisecond delay circuit is provided in the 12.687 Network in conjunction with the automatic range circuit (Drawing C012 687 0S). If there is a reversal of the input polarity, and the magnitude of the potential change is very large, the decay time of the d-c amplifiers may be sufficient to cause the TDVM to down range prior to the amplifier output building up to the true magnitude of the new input. The instrument would then have to up range and re-seek the proper range setting. To prevent this a 25 millisecond monostable multivibrator (Q2 and Q3, Drawing C012 687 0S) is triggered every time the sign multivibrator in the programmer changes state. The positive collector potential of Q2 sets the gray code counter to the 1000 volt scale setting and holds it there for 25 milliseconds.

**The overload indicator also lights when the instrument automatically up or down ranges; it indicates that the TDVM is inhibited during the time range changing occurs.*

This delay gives the d-c amplifier sufficient time to settle and then the range switching circuit is released (Q2 and Q3 re-set) and seeks the proper range. In addition, Q4 locks the indicator clear output so the readout cannot change and give an erroneous display. This feature prevents false outputs when the TDVM is feeding external equipment.

4. EXTERNAL CONTROL CIRCUITS

a. Remote Range Switching

The PROGRAMMING connector (P4) provides facilities for remote range selection of the 5001 TDVM. When the RANGE switch (S3) is placed in the REMOTE position, ground on the switch wiper is connected to terminal P4-3 (Drawing D026 158 0S, Sheet 2). By means of a wiper switch (similar to S3) or contact closures with P4-3 through P4-7 connected to the fixed contacts, the AUTO, 1000, 100, 10, and 1 volt range of the TDVM may be selected from a remote position. The operation of the TDVM is the same as when these ranges are selected by S3.

b. Single Cycle Command Circuit

The operation of the TDVM in the previous description assumed the instrument was free running (FUNCTION switch in the INT position) and that the input was sampled at an average rate of 200 times per second. However, by placing the FUNCTION switch in the MAN position the TDVM will sample the input only when the TRIGGER switch on the front panel is depressed. The actual sample will be made at the normal TDVM sampling rate (5 millisecond average), but, the instrument will then stop and hold this readout until the TRIGGER switch is again depressed.

As shown on D026 158 0S, Sheet 2, depressing the Trigger switch applies +12 volts to Q13 of the single cycle multivibrator, cutting it off. This causes Q14 to conduct, cutting off Q10 (the pullover inverter) which permits the TDVM to take a normal sample. At the end of the sample, however, the carry-in signal from the units counter cuts off Q14 and the pullover inverter conducts thus preventing a new sample from being taken. Q14 remains in this state until the TRIGGER switch is again depressed. Note that when the FUNCTION switch is in the INT position (free running) a continuous +12 volts is applied to Q13 preventing the single cycle multivibrator (Q13 and Q14) from affecting the sampling operation.

Placing the FUNCTION switch in the EXT position permits remote control of the single cycle command circuit. Any positive going pulse of approximately 10 volts amplitude and 4 microseconds rise time is sufficient to trigger the TDVM.

c. External Hold Circuit

The sampling rate of the TDVM is faster than the operating capabilities of most accessory equipment used in conjunction with it. This is true in the case of the EAI high-speed printer; the printer cycles at a rate of 3 operations per second (compared to the average of 200 operations per second of the TDVM).

An external *hold* input (P1-68, Diagram D026 158 0S, Sheet 2) is provided for the TDVM to permit the external equipment to hold a TDVM reading.

A negative potential applied to P1-68 clamps the indicator-clear gate in the conducting state. This prevents clearing the storage circuits, thus holding the readout data until the negative potential is removed. The hold voltage *does not* stop the continuous sampling operation of the TDVM in any other respect.

The readout data (on plug P1) for external use is available in both binary-coded decimal or straight decimal form. Thus the TDVM readout capabilities can be used with a multitude of external accessory equipment and is an especially fast analog-to-digital converter.

5. REFERENCE CIRCUITS AND POWER SUPPLIES

a. Reference Amplifier 6.464

This unit consists of a stable voltage element and a chopper-stabilized d-c amplifier; it functions as a -100 volt stable reference source. (See Drawing D026 158 0S, Sheet 1 for a simplified schematic diagram of this unit.)

The stable voltage source consists of a zener diode regulating network connected across the +40 volt supply. The diodes provide a stable potential of approximately 9.4 volts. This voltage is applied through R1 (NW6) to the input of the d-c amplifier (AR2). The amplifier gain (determined by the ratio of the feedback to input resistance) is adjusted to yield a -100 volt output. The -100 volt regulated output is the reference source applied to the common side of the summing resistors in the 26.116 Network.

The reference amplifier (AR2) utilizes a conventional automatic balancing circuit consisting of a 60 cycle vibrator and a three-stage, high-gain, a-c amplifier. Manual balance control is provided by R9 (Drawing D006 464 0S).

b. Power Distribution

The 5001 Series TDVM operates directly from a commercial 117/230 volt, 50 or 60 cycle source.

Schematic Diagram D026 139 0S, Sheet 4 shows the input a-c lines, the various rectifiers, and the associated regulator circuits (in block form). In addition, the distribution of the various d-c and a-c potentials is shown.

Detailed circuitry of all of the regulators (except Q1, Q2, and Q3 of the reference source) is shown on Schematic Diagram C043 094 0S. The reference regulator is shown in detail on Schematic Diagram D006 464 0S.

The power circuits of the TDVM supply the following d-c voltages: -100 volts, -110 volts, ±20 volts, ±12 volts, -8 volts, +40 volts, and +2 volts. The power circuits also energize the cooling fan and supply 6.3 volts a-c to the following circuits: the reference amplifier chopper, the dual d-c amplifier chopper, and the heater elements of the oven on the Comparator and Diode Gate.

CHAPTER V

MAINTENANCE

1. GENERAL CONSIDERATIONS

To assist the maintenance technician this chapter contains instructions on trouble analysis, printed circuit and transistor servicing techniques, as well as component location diagrams. Also included in this handbook are replaceable parts lists (Appendix I) and schematic and wiring diagrams (Appendix II).

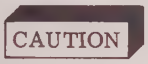
It should be noted that these maintenance instructions and data cannot cover all possible troubles and malfunctions; it is, therefore, essential that maintenance personnel be thoroughly familiar with the TDVM circuitry. General purpose maintenance data cannot be substituted for technical knowledge of the instrument.

2. TEST POINT CONNECTOR

As previously indicated, a TEST POINT Connector (P2) is mounted on the rear panel to permit monitoring instruments to be connected to certain circuit points in the TDVM. The connector terminations may be used directly or these points may be cabled to a central monitoring facility.

One suggested method of utilizing the TEST POINT connector for trouble-shooting purposes is to make comparisons between test-point potentials of an operational instrument and a malfunctioning instrument. In cases where only one instrument is available, all test point potentials should be measured and recorded when the instrument is first placed in service. Thus, if trouble occurs at a later time, the recorded set of normal voltages can aid in trouble-shooting.

Table VI lists all terminations of the connector, the circuit or source of the voltage at each terminal, and the circuit utilizing the particular voltage.



Do not short-circuit the -100 volt reference line to ground.

3. TROUBLE ANALYSIS

This paragraph lists some general techniques for trouble-shooting should a malfunction occur in the TDVM. Again it should be noted that not all possible areas can be covered and that the maintenance technician must fully understand the circuit operation of this instrument.

To assist in analyzing a malfunction, each circuit of the TDVM should be considered as being in one of three main groups: the input amplifiers with associated circuitry, the closed-loop logic circuits (including the indicator bank), and the power and reference supplies and regulators.

Trouble analysis is best accomplished by observing the action of the indicators and relating this action to possible causes of trouble. Accordingly, the suggested trouble-shooting procedures in the following paragraphs are grouped as to indicator display.

a. Indicators Displaying Fixed Reading

If a fixed reading is displayed regardless of the input, the most likely source of trouble is the logic circuitry. The following steps outline one suggested method of locating a malfunction of this type.

(1) Check the Programmer for the presence of either *count* or *shift* pulses at pin P (shift) or S (count) of connector A6-J1.

(2) If one or the other is *not* present, check for blocking-oscillator output pulses. The output frequency may be checked by using a calibrated time-base oscilloscope, and should be between 5 and 9 kc. If the blocking oscillator is functioning correctly, check the double AND gate consisting of Q1, Q2, and Q3 on the Programmer.

TABLE VI. Test Connector Terminations

CONNECTOR TERMINAL	CIRCUIT	VOLTAGE OR FUNCTION
1	Reference Amplifier Balance	For adjustment of Reference Amplifier Balance
2	-100V Reference	-100V d-c ±0.005%
3	+40 Power Supply Regulator	+40V d-c ±1%
4	Reference Zener Check	+9.4V d-c ±10%
5	-20 Power Supply Regulator	-20V d-c ±1%
6	-110 Power Supply Regulator	-110V d-c ±1%
7	Indicator Clear	See waveform *h* on Figure 7.
8	Amplifier-A Output	Determined by input and range setting.
9	Amplifier-B Output	Determined by input and range setting.
10	+2V Power Supply Regulator	+2V d-c ± 10%
11	+12V Power Supply Regulator	+12V d-c ±10%
12	+20V Power Supply Regulator	+20V d-c ±1%
13	-8V Power Supply Regulator	-8V d-c ±10%
14	-12V Power Supply Regulator	-12V d-c ±10%
15	Carry In Lead	Hold signal supplied by external printer or other readout equipment.
16	± Ground	
17	Amplifier-A Balance	See Paragraph 2*c*, Chapter III.
18	Amplifier-B Balance	See Paragraph 2*b*, Chapter III.

(3) If *count* or *shift* pulses are present, check the Q11-Q12 multivibrator on each of the BCD counters. (See Timing Diagram, Figure 7.) If necessary replace each BCD card in turn with a spare card known to be operational. (Interchanging the existing cards in the TDVM will not accomplish the desired check, since *all four cards are in closed loop.)*

b. Indicators Displaying All Zeros

An all-zero display regardless of the input generally indicates a malfunction in the input amplifiers or the comparator and associated circuits. Check as follows:

(1) Apply a positive input to the TDVM and monitor the output of each d-c amplifier at the TEST POINT connector. The first amplifier (AR1-b) output is at terminal 8, and the second amplifier (AR1-a) output appears on terminal 9.

(2) If the amplifiers are functioning normally, remove the Summing Resistor Network (NW-2) and check for positive voltage at pin 12 of relay K1. If a negative voltage appears at this point, check the relay, and the following Programmer circuits: Sign Check Multivibrator (Q11-Q12), Sign Multivibrator (A6-Q7), and the Relay Amplifier (Q5).

(3) If voltage at K1-12 is normal (positive), change the polarity of the TDVM input signal, and again check for positive voltage at K1-12. If this point is now negative check all circuits listed in sub-paragraph (2).

(4) If the voltage at K1-12 remains positive *after* changing the input polarity, proceed to the comparator. Under the present conditions the *Comp Out* - line should be at -10 volts, and the Comp Out + line close to zero.

(5) If all of the previously-listed circuits appear to be functioning normally the trouble may be in one of the BCD Counter cards. This can be verified by replacing each card in turn with a card known to be operational.

c. Indicators Display Continually-Changing Random Digits

A display of this type usually indicates that the logic circuitry is functioning properly, but that trouble exists in the input circuits. Proceed as follows:

(1) Remove relay K1 and attempt to zero-set the instrument.

(2) If zero-setting can be accomplished, the input amplifiers and associated circuitry should be checked.

d. Two-Digit Display on One Indicator

If one of the indicators displays two digits simultaneously, the usual cause is diode leakage in the BCD-to-decimal converter section of a Readout Storage Decade. This is verified by the appearance of certain combinations of digits such as 8 and 9, 3 and 5, etc.

NOTE

Noise on the input signal may cause one or more of the indicators to flicker between digits.

4. SERVING TECHNIQUES

a. Printed Circuit Servicing Techniques

The repair procedures in this section are offered for maintenance personnel unfamiliar with servicing printed circuit assemblies. It is suggested that these techniques be used to avoid damaging the printed-circuit boards when repair or component replacement is necessary.

(1) To replace wire leads or components fastened to the board with axial leads, use diagonal cutting pliers. These cutters enable the solder fillet and leads to be cut flush with the surface of the conductor. To install the new component, bend the leads and insert into the board holes. When soldering hold the tip of the iron in contact with the end of the lead so that solder runs down the lead and forms a smooth fillet on the surface of the conductor. Use a small, well-tinned, 35 or 40 watt soldering iron and work quickly to avoid damage to the board or component. The soldering process can be accomplished rapidly by having both surfaces well-tinned and using a relatively soft solder such as a 60/40 type, low-temperature solder. Do not heat the surface of the conductor directly as this causes the conductor and the base to separate.

(2) Components with stiff leads or terminals (such as potentiometers, sockets, electrolytic capacitors, etc.) are best removed by clipping each terminal with the cutting pliers. If this is difficult or undesirable, heat each joint individually and brush away the melted solder with a small stiff-bristle brush. When all solder has been removed in this manner, the component may be easily removed.

(3) If a conductor opens due to a break or crack in the card, the gap may be bridged with a piece of tinned bus wire. The wire should be carefully soldered across the open section.

b. Transistor Circuit Servicing Techniques

Servicing and trouble-shooting procedures applicable to transistorized circuitry are in many ways similar to techniques used in vacuum tube circuits. However, certain precautions must be observed when trouble-shooting, repairing, or replacing components in transistor circuits. It is felt that the suggestions and techniques outlined in the following paragraphs may be of some assistance to maintenance personnel unfamiliar with servicing transistorized equipment.

(1) While practically all transistors are mechanically rugged, these units are easily damaged by excessive heat. If it becomes necessary to perform soldering operations in close proximity to a socket-mounted transistor, the transistor should be removed. In cases when the transistor is soldered directly to the circuit board, some form of heat shielding should be provided to keep the heat of the iron away from the transistor. In all cases the use of a hot, well-tinned iron (not larger than 35 or 40 watts) will enable the soldering operation to be performed rapidly.

If removal of a directly-soldered transistor is necessary, the transistor *must* be provided with some form of heat protection. This is best accomplished by grasping the leads with long-nose pliers between the body of the transistor and the heat source. The pliers function as a heat sink and should be kept on the lead for a short time after the iron is removed. In circuits where a socket is employed, the transistor should be removed before the soldering iron is applied to any of the socket terminals.

Power transistors in amplifiers and power supplies are often mounted on metal chassis plates which function as heat sinks. Since the collectors of these transistors are generally operated at relatively high potentials, an insulating washer is required between the transistor body and the heat sink. When replacing any of these components, be certain that the washer and the plastic insulating sleeves provided for the mounting screws are in place. To further increase the insulating properties of the washer and to provide thermal conductivity, a light coating of silicone lubricant (Dow Corning 4-Compound or equivalent) should be applied to both sides of the washer before installation.

As a final precaution before power is applied to the repaired unit, connect an ohmmeter between the heat sink plate and the transistor body (collector), to ensure that no short or high-leakage path exists between these points.

(2) Transistors are quickly damaged by applying operating potentials of excessively high amplitude or incorrect polarity. Because of these limitations, socket-mounted transistors should never be removed or inserted while power is applied to the circuit. This precaution is necessary to prevent any surge or transient voltages, which may be generated during insertion or removal, from damaging the transistors.

Another potential source of transistor overload is in the incorrect use of a signal generator for trouble-shooting purposes. Many of the audio generators which may be used for this purpose are capable of supplying relatively high signal voltages which can damage or destroy a transistor (particularly when applied to low-level stages). Always begin signal injection with the generator controls set for minimum output and then gradually increase the signal level until the desired results are achieved.

(3) When making continuity checks and resistance measurements in transistorized circuits, some precautions must be observed regarding the test meter used for this purpose. One factor which must be considered is the polarity of the internal battery used for the ohmmeter section of the instrument. Most commercial volt-ohmmeters or multi-testers use an arrangement where the *ohms* lead is connected to the positive terminal of the battery, with the ground or *common* lead connected to the negative side. However, in some instruments the reverse is true. Before connecting the meter to a transistorized circuit, the battery polarity should be determined. (This may be accomplished by connecting the ohmmeter leads to a low-range voltmeter.) Since some transistor circuits utilize electrolytic capacitors with very low voltage-ratings (6 volts or less in some cases), false indications and capacitor damage may occur if the meter polarities are reversed. Another factor to be considered is the meter-battery voltage. Certain instruments use batteries with potentials of 6 volts or greater (up to 45 volts in some cases). Improper use of a meter of this type can easily ruin transistors and low-voltage electrolytic capacitors. For these reasons it is suggested that the ohmmeter section of a vacuum-tube voltmeter be used for resistance measurements in transistor circuits. Practically all of these instruments utilize a 1.5 or 3 volt battery for the ohmmeter with the positive side of the internal battery connected to the *ohms* lead, and the negative side connected to the instrument case or *common* lead.

(4) In the course of servicing an amplifier or power supply circuit, the transistor itself may be suspected of being defective. In this case, as in vacuum tube circuitry, the best check is to substitute the suspected transistor with a known good unit. Commercial transistor testers are available, but in some applications these instruments do not yield conclusive results. Substitution affords the most reliable check.

5. INDICATOR LAMP REPLACEMENT

To replace the indicator lamps remove the screws on each side of the indicator load. Slide the entire assembly out of the TDVM for free access to the lamps. (See Figure 19.)

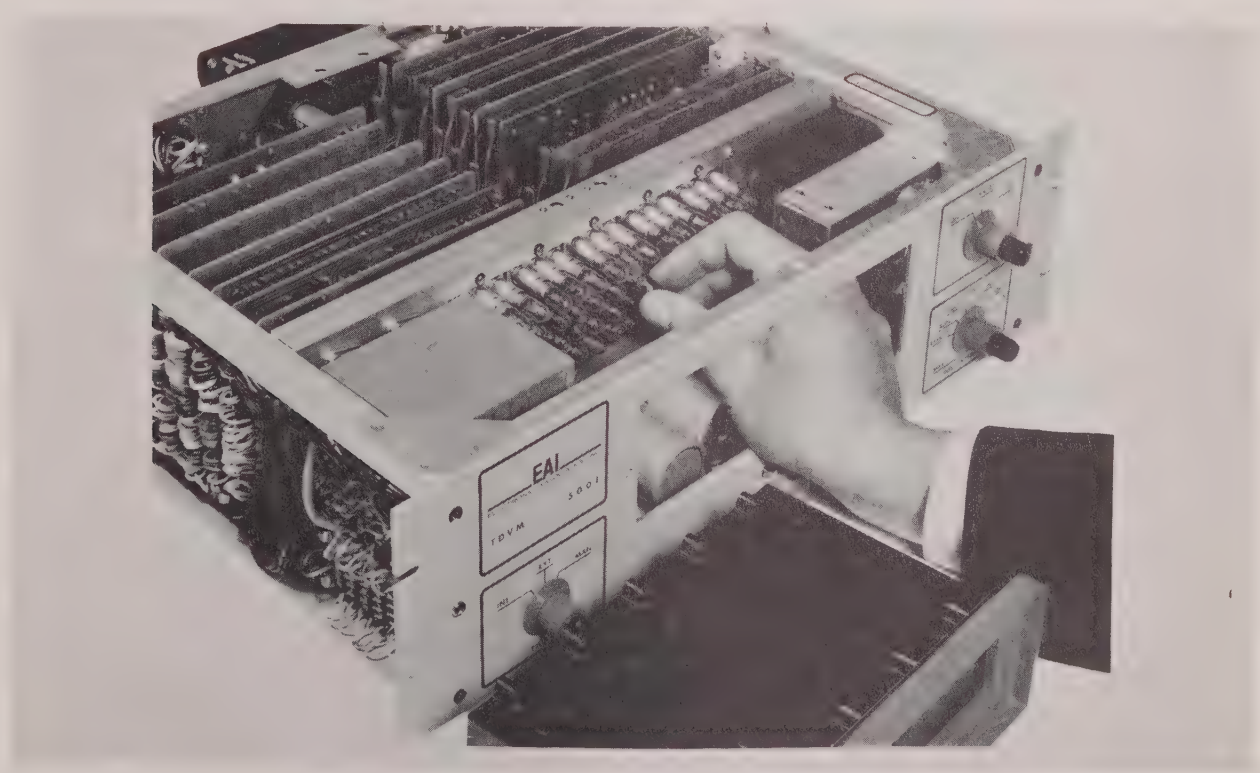


Figure 19. Indicator Lamp Replacement

6. COMPONENT LOCATION DIAGRAMS

The figures in this section (Figure 20 through 32) are provided to assist the maintenance technician in readily locating components within the TDVM chassis as well as the individual components on the printed circuit cards.

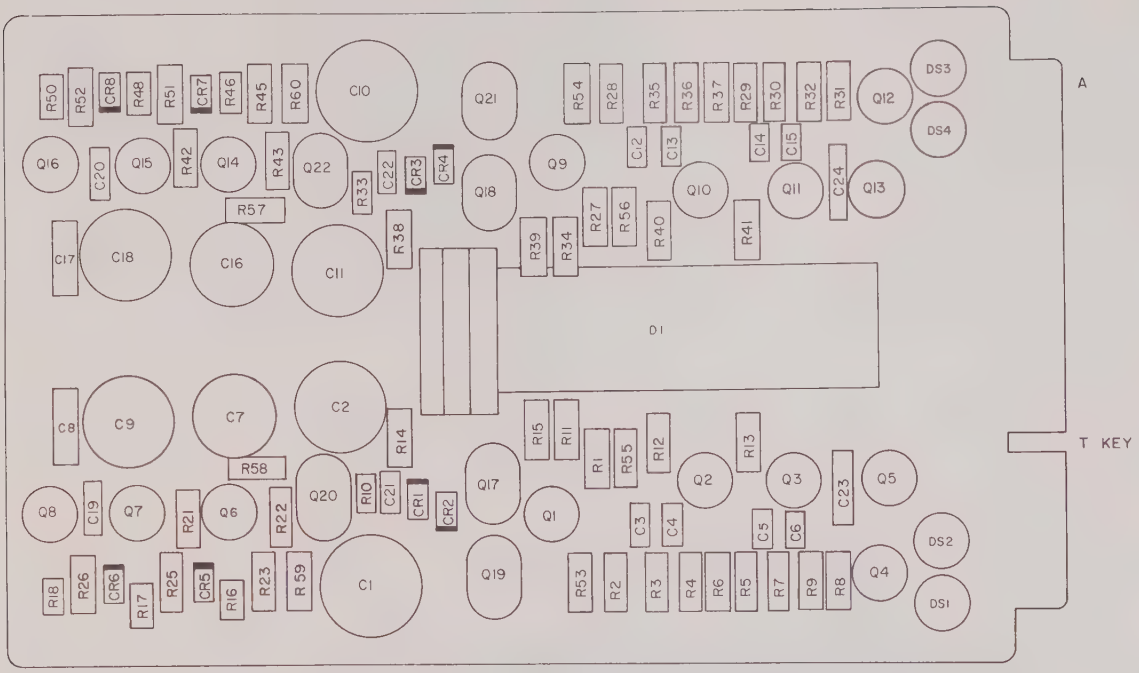


Figure 20. Dual D.C. Amplifier 6.463 Component Location

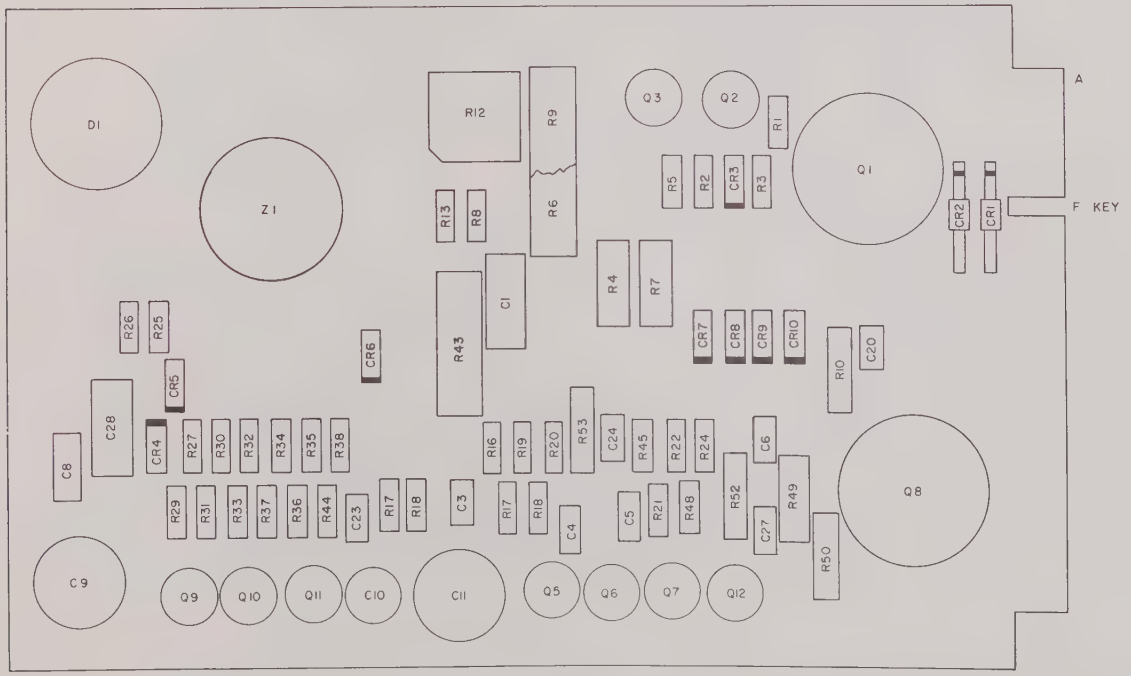


Figure 21. Reference Amplifier 6.464 Component Location

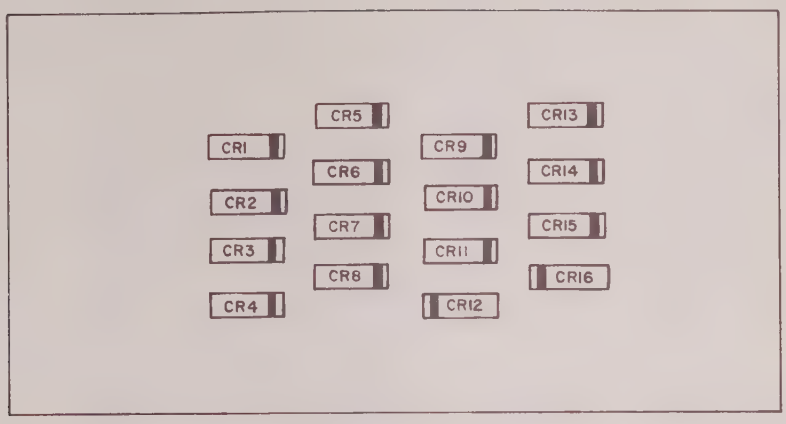


Figure 22. Diode Network 12.675 Component Location

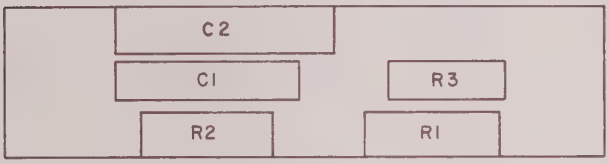


Figure 23. Reference Amplifier Network 12.722 Component Location

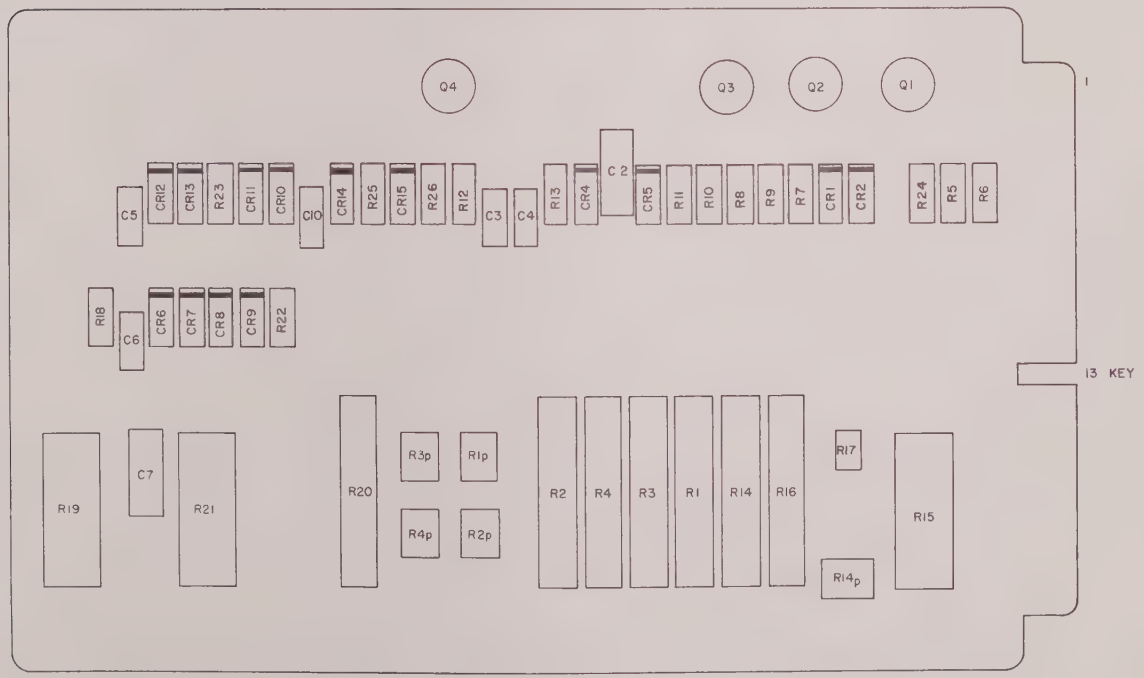


Figure 24. Network Card 12.687 Component Location

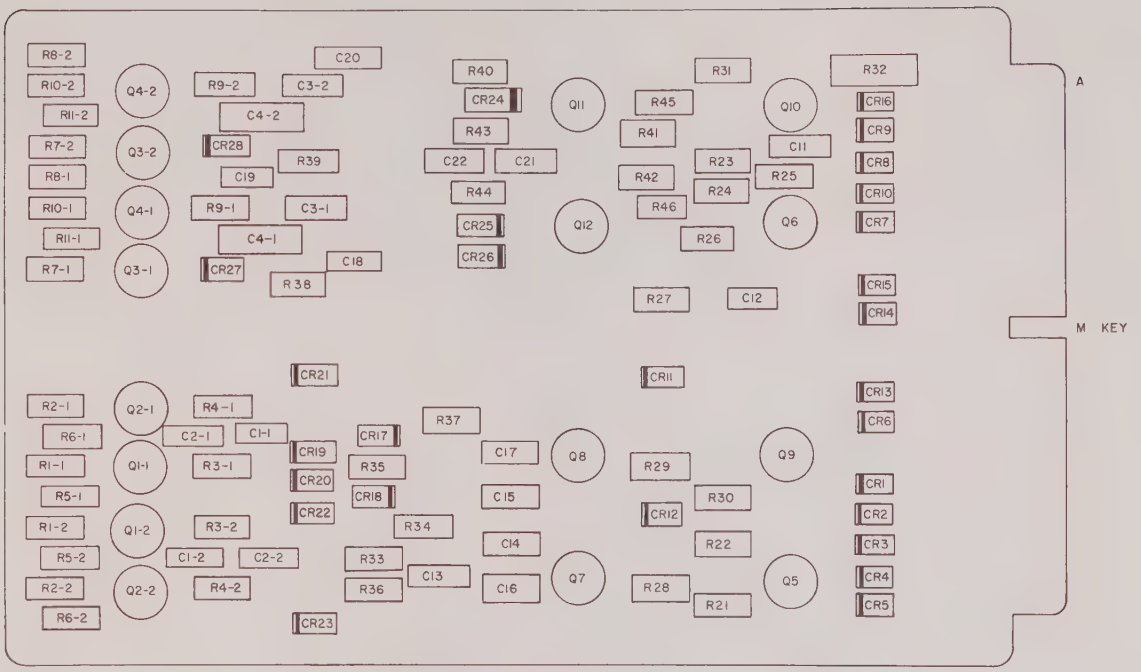


Figure 25. Automatic Range Switching Circuits 14.115 Component Location

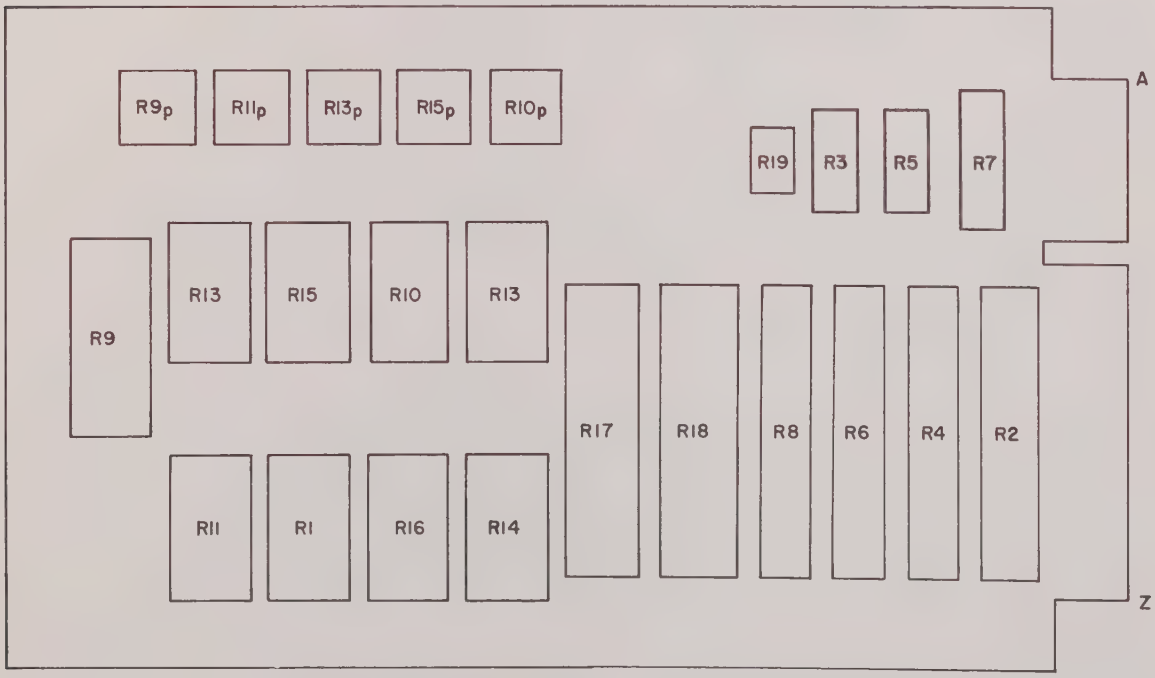


Figure 26. Summing Resistor Network 26.116 Component Location

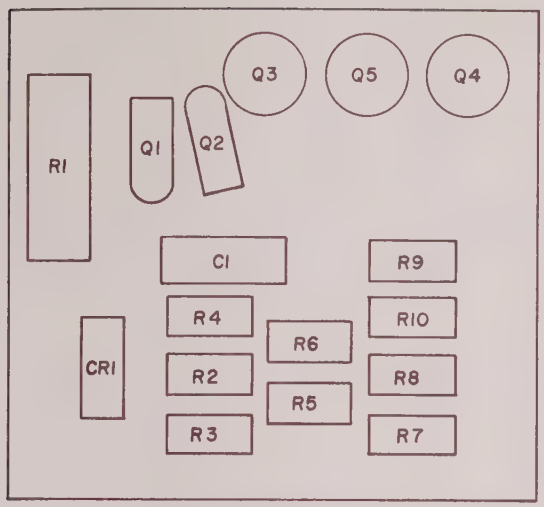


Figure 27. Comparator Amplifier 26.134-2 (Part of 26.096-1) Component Location

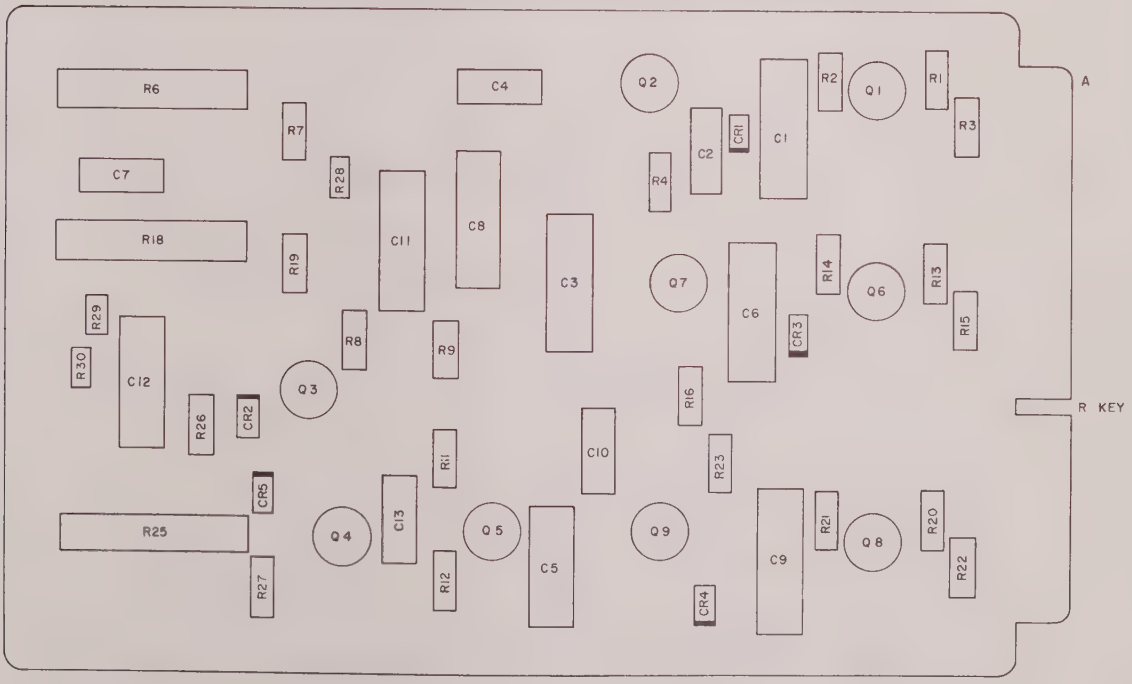


Figure 28. Power Supply Regulator 43.094 Component Location

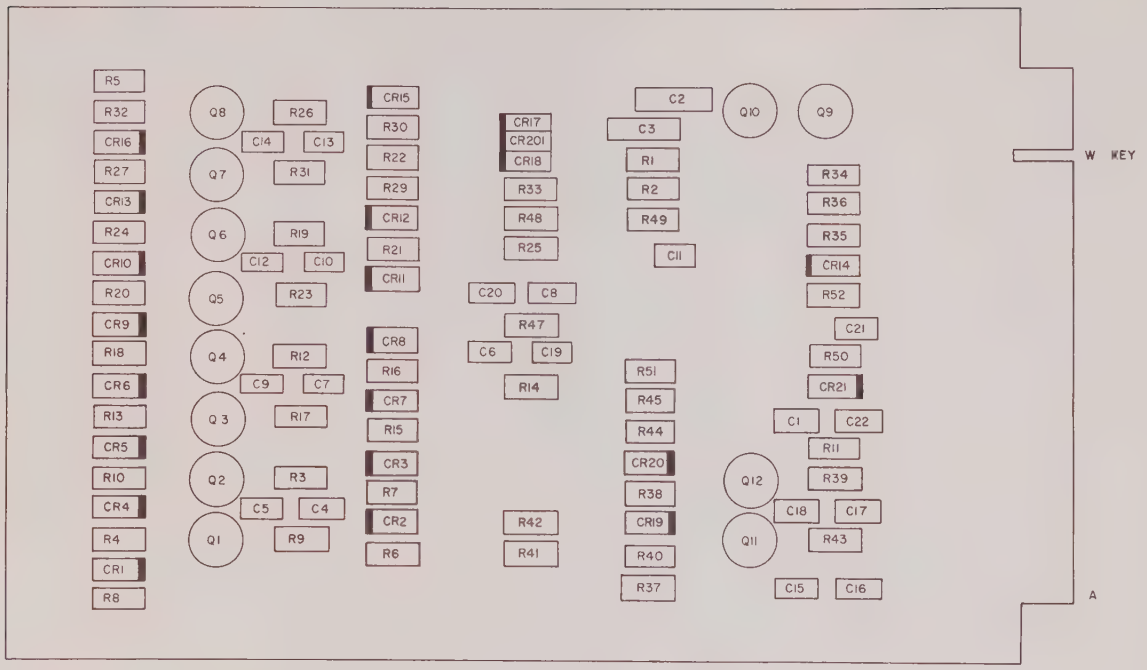


Figure 29. Binary Coded Decade Counter 44.139-1 and 44.139-5 Component Location

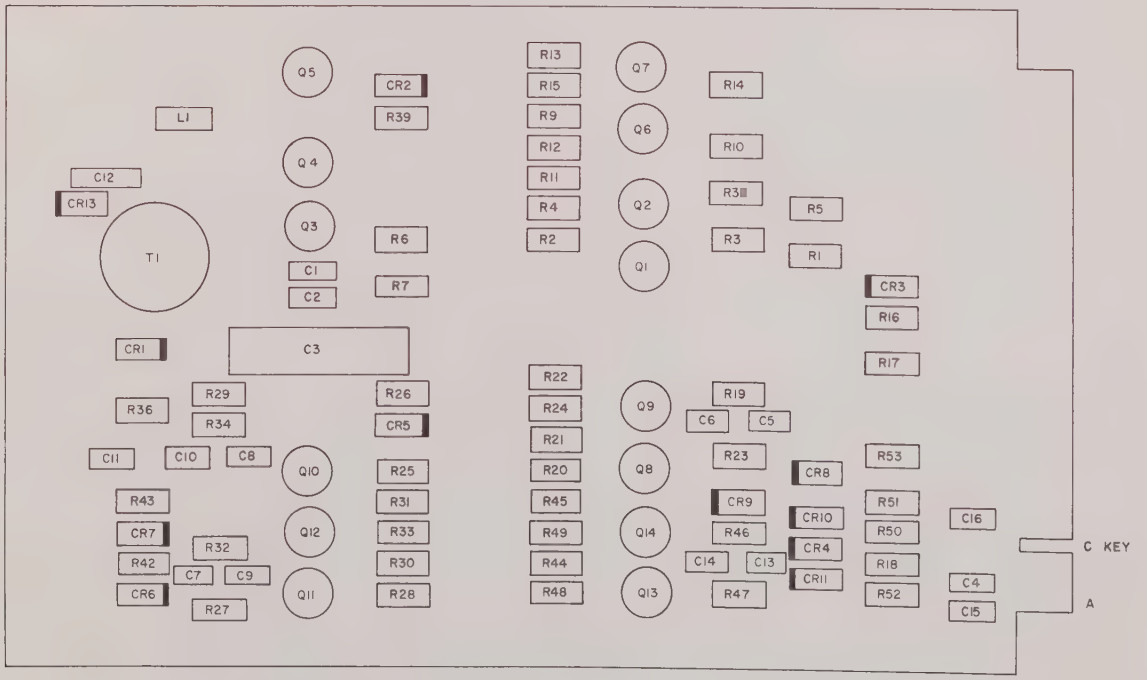


Figure 30. Programmer 44.170-3 Component Location

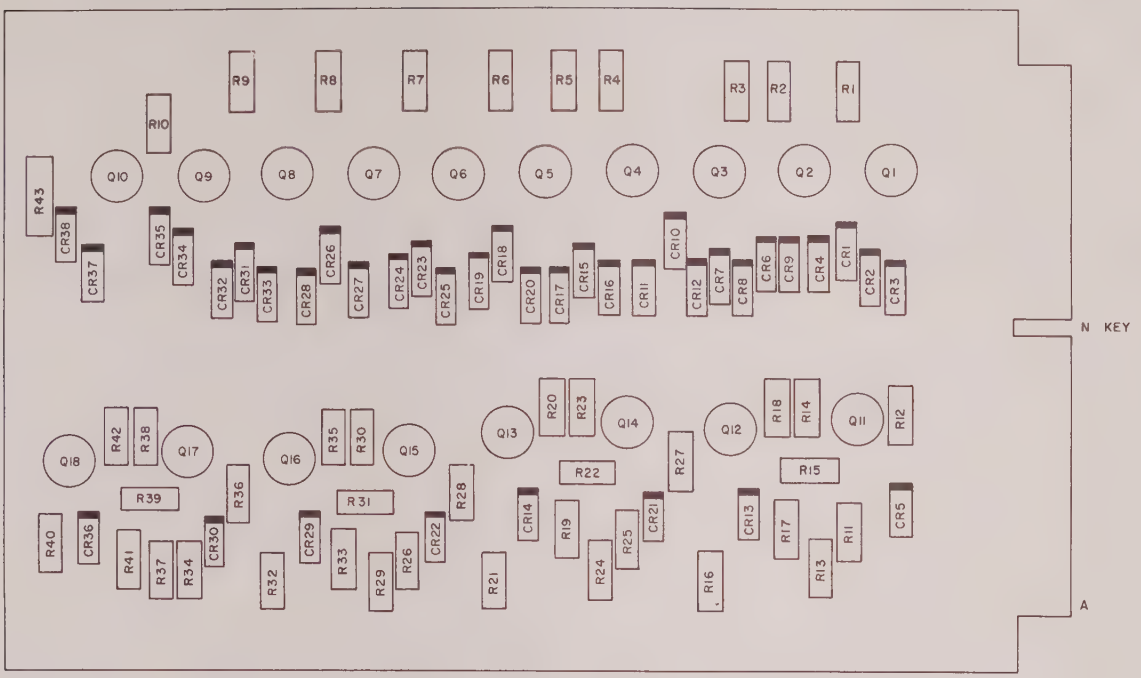


Figure 31. Readout Storage Decade 51.010-1 Component Location

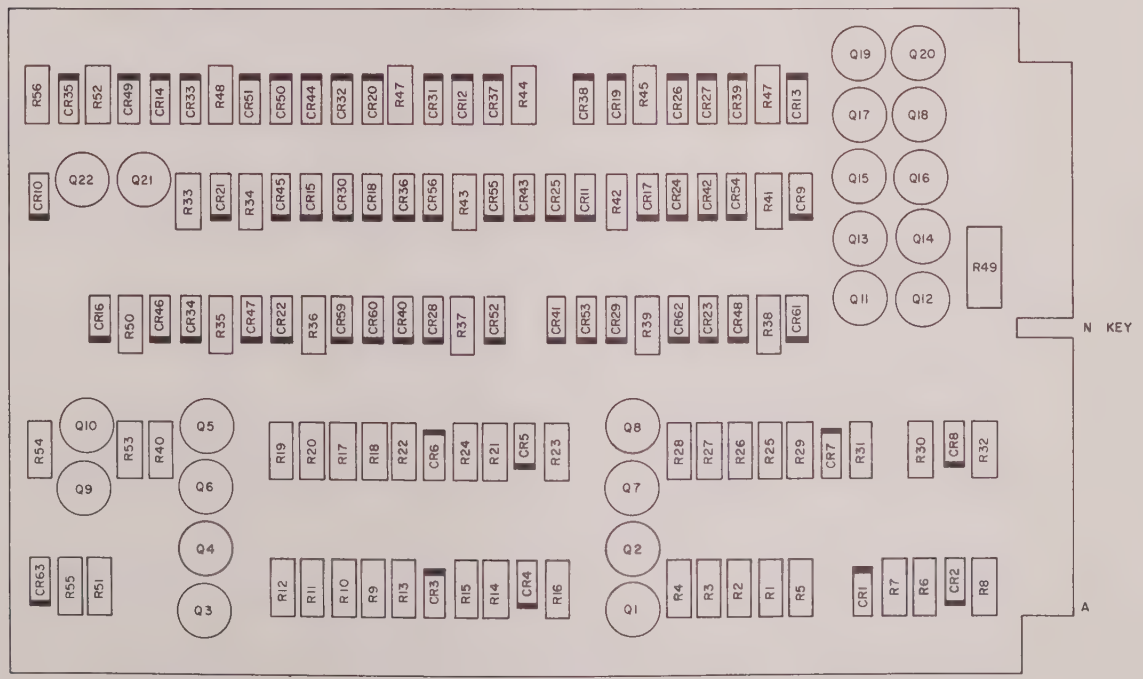


Figure 32. Readout Storage Decade 51.080-1 Component Location

CHAPTER VI

CALIBRATION

1. INTRODUCTION

This chapter contains instructions and procedures for a complete calibration of the 5001 TDVM. As previously indicated each instrument is completely adjusted and calibrated prior to shipment and should require no further adjustments upon receipt. However, if it should later become necessary to replace any components directly affecting the accuracy of the instrument, re-calibration will be necessary.

It should be noted that calibration of an instrument with the accuracy of the TDVM is an exacting procedure requiring precision equipment and extremely stable voltage sources not normally available in field installations. Unless such equipment is available, EAI recommends that the TDVM be returned to the factory if re-calibration becomes necessary.

2. REQUIRED EQUIPMENT

The equipment listed in the following table is required for a complete re-calibration of the 5001 TDVM.

TABLE VII

COMPONENT	RECOMMENDED TYPE	USED FOR
Precision Voltage Divider (100,000 ohms)	Leeds and Northrup, Model 4395 (or equal)	D-C Gain Adjustment Summing Network Trimming Adjustments Reference Adjustment
Galvanometer	Leeds and Northrup, Catalog No. 2430D (or equal)	D-C Gain Adjustment Summing Network Trimming Adjustments Reference Adjustment
Microammeter	Hewlett-Packard, Model 425A (or equal)	TDVM Unloading Adjustment
Secondary Standard Voltage Cell (Calibrated to .005%)	Epley No. 103 (or equal)	Reference Adjustment
Stable D-C Source (about 100 volts)		D-C Gain Adjustment
30,000 ohm Ten-Turn Potentiometer	Helipot, Model 30,000-A1 (or equal)	Summing Network Trimming Adjustments

3. PRELIMINARY PROCEDURES

Before proceeding with the calibration procedure outlined in Paragraph 4 of this Chapter, the preliminary checks and adjustments in this paragraph should be performed. This will ensure that the TDVM is functioning normally with all amplifiers balanced and power supply outputs at the correct levels.

Proceed as follows:

a. Remove the TDVM from the rack or dust cover; connect the intrument to an a-c line through a variable auto-transformer so that the applied primary a-c voltage may be varied.

b. Set the input to 117 volts a-c and permit the TDVM to warm-up for two hours with the power control switch in STANDBY.

c. Using a VTVM (accurate to ±1%) check (and adjust if necessary) the following d-c operational voltages: ±40V, ±20V, ±12V, -8V, +2V, and -110V. All voltages except the +40, ±20 and -110 volt outputs should be within 10% of the rated level with the line voltage first set at 105 volts and then at 125 volts. The +40 and ±20 volt levels should be within 1% of the rated value and the -110 within ±5%. Reset the line level to 117 volts.

d. Balance each of the d-c amplifiers as outlined in Paragraph 2*b*, Chapter III. Balance the reference amplifier in the same manner, connecting the meter between pins 1 and 16 of the TEST POINT connector (P2) and adjusting R9 on Reference Amplifier card.

e. Using a calibrated time base oscilloscope, check the frequency of the Programmer blocking oscillator. The correct value is between 5 and 9 kc.

This completes the pre-calibration checks and adjustments; the instrument is now ready for the calibration procedure described in the following paragraphs.

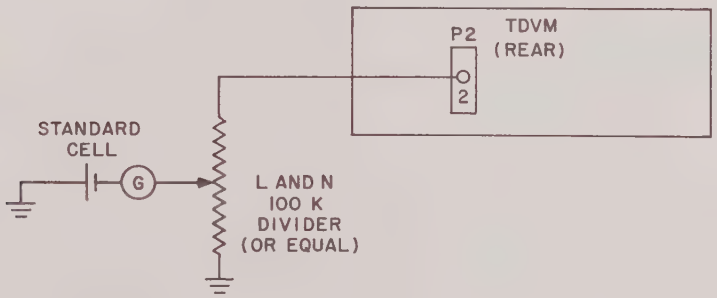


Figure 33. Reference Adjustment, Test Setup

4. CALIBRATION PROCEDURE

The adjustments listed in this paragraph should be made in the order given.

a. Reference Amplifier Adjustment

Set up the test circuit as illustrated in Figure 33. (The setting of the L and N divider is determined by the actual potential of the standard cell.)

Adjust R12 on the Reference Amplifier 6.464 until a null is obtained on the galvanometer. This adjustment sets the reference at -100 volts. (For the physical location of R12 see the Reference Amplifier 6.464 component location diagram, Figure 21.)

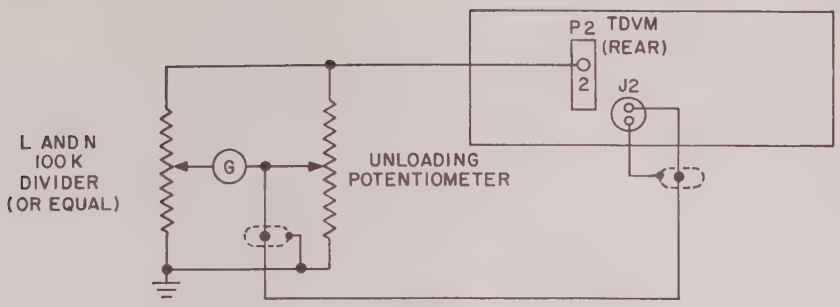


Figure 34. Full Scale and Trim Pot Adjustment, Test Setup

b. Full Scale Adjustment

(1) Set up test circuit as shown in Figure 34.

(2) Reset ZERO adjustment.

(3) Set the TDVM range switch to the 100 volt position (manual range setting).

(4) Set the L and N Divider for -7.775 volts; adjust the test circuit unloading potentiometer for a galvanometer null.

(5) Adjust the FULL SCALE ADJ potentiometer on the rear of the TDVM for a displayed reading of -7.775 volts.

NOTE

The display should remain constant over a wide range of the FULL SCALE ADJ potentiometer. Set the potentiometer in the center of this range.

(6) Switch the TDVM to STANDBY and re-check the Zero adjustment.

c. Summing Resistor Trim Pot Adjustment

Use the test set up shown in Figure 34. These adjustments should not be attempted until the ZERO adjustment (Paragraph *b*, Step 6) check is made. Re-check the ZERO adjustment (in the STANDBY mode) after each of the procedural steps outlined in this paragraph. Each of the following steps should be performed with the TDVM set on the 100 volt range.

The trim pot physical locations are shown on the Summing Resistor Network 26.116 component location diagram (Figure 26).

(1) *8000 Trim Pot Adjustment*

(a) Apply an input of -80.015 volts to the TDVM.

(b) Adjust R9p (NW2) until the TDVM readout flickers between -80.01 and 80.02*.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

**Approach the settings from the high side, i.e., 80.03, 80.02, and then to the flickering state.*

(2) *4000 Trim Pot Adjustment*

(a) Apply an input of -40.015 volts to the TDVM.

(b) Adjust R11p (NW2) until the TDVM readout flickers between -40.01 and 40.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(3) *2000 Trim Pot Adjustment*

(a) Apply an input of -20.015 volts to the TDVM.

(b) Adjust R13p (NW2) until the TDVM readout flickers between -20.01 and -20.02.

(c) Set TDVM to STANDBY and re-check the ZERO setting.

(4) *1000 Trim Pot Adjustment*

(a) Apply an input of -10.015 volts to the TDVM.

(b) Adjust R15p (NW2) until the TDVM readout flickers between -10.01 and -10.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(5) *800 Trim Pot Adjustment*

(a) Apply an input of -8.015 volts to the TDVM.

(b) Adjust R10p (NW2) until the TDVM readout flickers between -8.01 and -8.02.

(c) Set the TDVM to STANDBY and re-check the ZERO setting.

(d) Apply an input of -87.77 volts and check the FULL SCALE ADJ setting. If this adjustment requires resetting, repeat steps (1) through (5).

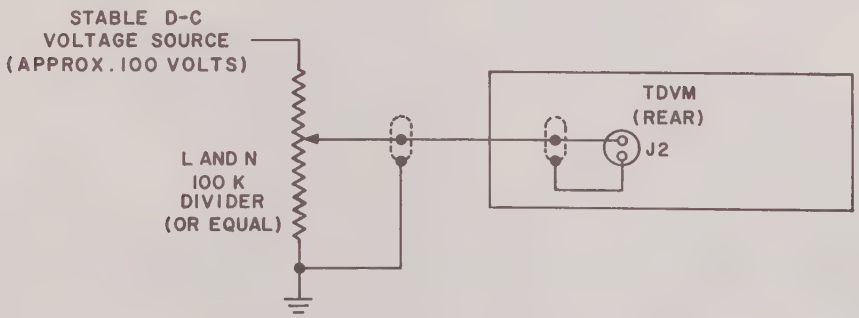


Figure 35. D.C. Gain Adjustment, Test Setup

d. D.C. Gain Adjustment

(1) Set up the test circuit as shown in Figure 35.

(2) Set the TDVM to the 10 volt scale.

(3) Apply a negative potential of approximately -10 volts to the TDVM input; record the reading.

(4) Apply a positive potential *equal in magnitude* to the potential used in step (3) to the TDVM input.

(5) Adjust R20 (NW7, Figure 24) for a readout equal to the recorded value to step (3).

(6) Repeat steps (3) through (5).

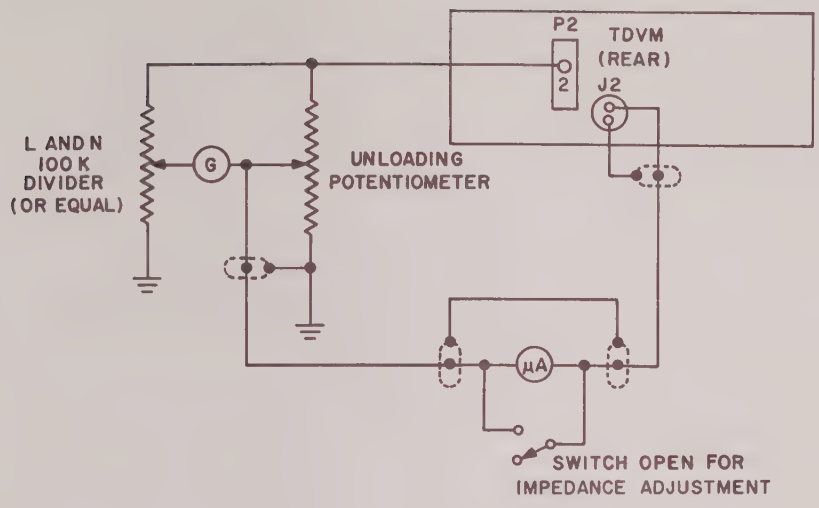


Figure 36. TDVM Unloading Adjustment, Test Setup

e. TDVM Unloading

(1) Set up the test circuit illustrated in Figure 36. (The switch by-passing the meter permits setting the L and N Divider without subjecting the meter to excessive current flow.)

(2) Set the TDVM to the 10 volt range and apply an input of -10.00 volts.

(3) Set the INPUT IMPEDANCE switch to MAX and open the meter bypass switch.

(4) Adjust R4 (NW7, Figure 24) for minimum current through the microammeter (maximum allowable reading of 0.02 microamperes). This sets the input impedance to 500 megohms or greater. (Be sure the current measured on the microammeter is from the source voltage. Improper adjustment can cause the input amplifier circuit to appear as a negative impedance.)

(5) Switch the IMPUT IMPEDANCE switch to the 10M position (with the 10 volts still applied).

(6) Adjust R3 (MW7) for 1 microampere of current. This sets the input impedance to 10 megohms.

(7) Close the meter bypass switch and set the TDVM to the 1 volt range. Apply an input of 1.000 volt.

(8) Set the INPUT IMPEDANCE switch in the MAX position. Open the bypass switch and adjust R2 (NW7) for minimum current through the microammeter (maximum allowable reading of 0.004 microamperes). This sets the input impedance to 250 megohms or greater.

(9) Switch the INPUT IMPEDANCE switch to the 10M position.

(10) Adjust R1 (NW7) for 1 microampere of current. This sets the input impedance to 10 megohms.

APPENDIX I

REPLACEABLE PARTS LISTS

This appendix lists all replaceable parts in the 5001 Transistorized Digital Voltmeter. In each case a brief description of the part and a manufacturer's number are listed. Where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, and index page precedes the individual spare parts lists.

The category column in the parts list is intended to indicate the availability of each listed part so that a replacement part can be obtained as quickly as possible. The components in category-A are standard electronic items that are usually available from any commercial electronic supplier. In order to expedite obtaining items of this nature, it is suggested that they be purchased from a local source whenever possible. If necessary these parts may be ordered from EAI.

The components in category-B are items that can be obtained from EAI or any of the listed manufacturers. However, in most cases EAI is in a position to offer the most rapid service on items in this category.

The parts in category-C are custom-made components and proprietary items that are available only from EAI. When ordering items of this type, please specify the type number and serial number of the basic unit in which the part is located, as well as the part identification.

Where possible, sufficient information is given for category-C items to permit an *electrically-similar* replacement part to be obtained locally. Thus, if desired, a temporary repair may be made while the *exact* replacement is being obtained from EAI. *Note, however, that EAI does not guarantee that the affected unit will operate within specifications when the specified category-C part is not used.*

PLEASE NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. IN ALL CASES EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

5001 TRANSISTORIZED DIGITAL VOLTMETER, MODEL 26.158

	Model Number	Component	Page
1.	26.158	5001 TDVM (Automatic Range Switching)	AI-3
2.	6.463	Dual D.C. Amplifier	AI-5
3.	6.464	Reference Amplifier	AI-8
4.	12.675	Diode Network	AI-11
5.	12.687	Network Card	AI-12
6.	12.722	Reference Amplifier Network	AI-14
7.	14.115	Automatic Range Switching Circuits	AI-15
8.	26.096-1	Comparator and Diode Gate	AI-17
		26.134-2 Comparator Amplifier	AI-17
9.	26.116	Summing Resistor Network	AI-18
10.	43.094	Power Supply Regulator	AI-20
11.	44.139-1	Binary Coded Decade Counter	AI-22
12.	44.139-5	Binary Coded Decade Counter*	AI-22
13.	44.170-3	Programmer	AI-23
14.	51.010-1	Readout Storage Decade	AI-25
15.	51.080-1	Readout Storage Decade	AI-26

**Identical with 44.139-1 except that CR18 (Item 3) has been deleted, and CR201 has been added. CR201 is identical with Item 3 on 44.139-1 Unit.*

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Electrolytic: 4000 UF, 15V Sprague TVL-1173	516 044 0	A
2	C2	Capacitor, Fixed, Electrolytic (Dual): 200-200 UF +100%-10% 250V; P.R.Mallory FP217.74	516 139 0	A
3	C3-5	Capacitor, Fixed, Electrolytic: 2000 UF, 50V; P.R.Mallory MP TS-17123	516 239 0	B
4	C6	Capacitor, Fixed, Paper: .5UF ±10%, 600V; Sprague BP506	520 074 0	A
5	C7	Capacitor, Fixed, Plastic: .47UF ±5%, 150V Southern Electronics	521 059 0	C
6	CR1-4	Rectifier, Silicon: Hughes Semi-Conductor HR10212	614 034 0	B
7	DSI-4	Digital Display Indicator: Industrial Electronic Engineers, Inc. 10984-47	B554 016 0	C
8	DS5	Digital Display Indicator: Industrial Electronic Engineers, Inc. 10B06-47	B554 022 0	C
9	F1	Fuse, Cartridge, Slow Acting Type: 1 amp, 125V; Littelfuse 313001	570 111 0	A
10	K1	Relay: 430 ohm DC Coil, 4 Form C Contacts; Allied Controls T-154X-158	B618 157 0	C
11	K2,3	Relay: 24V DC Coil, 4 Form C Contacts; C.P.Clare Type J Code 22 A296341	B618 165 0	C
12	Q1-4	Transistor, Germanium: PNP; Bendix 2N1136A Type	686 066 0	B
13	R1-S4	Switch, Rotary and Resistor, Variable: 10K ohms	C65B 195 0	C
14	R2,3	Resistor, Variable, Composition: 10K ohms ±20%, ½W; Allen-Bradley Type G	A642 364 0	A
15	R5,6	Resistor, Fixed, Wirewound: 20 ohms ±5%, 10W; Milwaukee Resistor Co.	A636 421 0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT CAN BE PURCHASED LOCALLY OR FROM EAI.
C - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.
THE PROPER EAI PART SHOULD BE INSTALLED FOR CATEGORY C ITEMS. A COMPLETE DESCRIPTION IS GIVEN TO PROVIDE FOR TEMPORARY REPAIRS; HOWEVER, EAI WILL NOT BE RESPONSIBLE IF UNIT IS NOT WITHIN SPECIFICATIONS UNDER THESE CONDITIONS.

UNIT TITLE

Auto Range Switching TDVM

MODEL NO.

26.158 Sh 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
16	R7	Resistor, Fixed, Wirewound: 33 ohms ±5%, 2W; Ward Leonard 2X33	636 425 0	A
17	R8	Resistor, Fixed, Wirewound: 100 ohms ±5%, 10W Milwaukee Resistor Co.	A636 422 0	B
18	R9	Resistor, Fixed, Wirewound: 82 ohms ±5%, 2W; Ward Leonard 2X82	636 426 0	A
19	R10,12	Resistor, Fixed, Composition: 6.8 ohms ±5%, 1W; Allen-Bradley GB	627 689 0	A
20	R11	Resistor, Fixed, Wirewound: .5ohms ±5%, 10W; Milwaukee Resistor Co.	A636 423 0	B
21	R13	Resistor, Fixed, Composition: 6.8K ohms ±10% 2W; Allen-Bradley HB	628 682 1	A
22	R14	Resistor, Fixed, Composition: 470 ohms ±10% ½W; Allen-Bradley EB	626 471 1	A
23	S2	Switch, Toggle: DPDT; Microswitch 6AT3	664 029 0	B
24	S3,8	Switch, Rotary (Dual): 2 Sections; Centralab 31-1091-2	C658 194 0	C
25	S5,7	Switch, Rotary and Push: Centralab PA-037 and Grayhill, Inc. 23-1	C658 196 0	C
26	T1	Transformer, Power: 105V/117V/125V, 50/60 cps Primary, 2EA 39VCT, 1 EA 36 VCT, 15VCT, 1 EA 6.3V and 1 EA 220VCT Secondaries; James Electronics A-7504	B684 157 0	C
27		Resistor Network	12.725	C

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
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UNIT TITLE

Auto Range Switching TDVM

MODEL NO.

26.158 Sh 2 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1, 10	Capacitor, Fixed, Electrolytic: .47UF, 50V	Order by Description	C
2	C2,9,11,18	Capacitor, Fixed, Electrolytic: 1250 UF +100% - 10%, 3V; Callins Industries, Inc. PSS Series	A516 184 0	C
3	C3,12	Capacitor, Fixed, Ceramic: 100 PF ± 10%, 1000V; Cornell-Dubilier L10T1	515 019 0	A
4	C4,13	Capacitor, Fixed, Ceramic: .015 UF ±20%, 500V; Sprague Electric 33C30A	515 140 0	B
5	C5,14	Capacitor, Fixed, Ceramic: 47 PF ±10%, 1000V; Cornell-Dubilier L10Q47	515 017 0	A
6	C6,15,19,20	Capacitor, Fixed, Ceramic: 1000 PF ±20%, 75V; Glenco Min-Z-1000-M	515 075 0	B
7	C7,16	Capacitor, Fixed, Electrolytic: .22 UF, 50V	Order by Description	C
8	C8,17	Capacitor, Fixed, Electrolytic: 4.7 UF ±10%, 35V; Sprague Products 150D475X9035B2	Order by Description	A
9	C21,22	Capacitor, Fixed, Ceramic: 8 PF ±10%, 1000V; Cornell-Dubilier C10V8C	515 087 0	A
10	C23,24	Capacitor, Fixed, Ceramic: .05 UF +100%-20%, 30V; Centralab DA-503	515 183 0	A
11	CR1-4	Rectifier, Silicon: Hughes Semi-Conductors HR10212 Type	614 034 0	B
12	CR5-8	Diode, Germanium: Clevite CTP462 Type	614 043 0	B
13	D1	Chopper: 6.3V 60 cps Coil, DPDT BBM Contacts; James Electronics C-2335	530 042 0	C
14	DSI-4	Lamp, Incandescent: 330 Type	578 020 0	A
15	Q1,2,9,10	Transistor, Germanium: PNP; General Transistor Corp. GT1236	B686 028 0	C
16	Q3,4,11,12	Transistor, Germanium: PNP; Motorola 2N652 Type	686 084 0	B

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UNIT TITLE
Dual DC Amplifier

MODEL NO.
6.463 Sh 1 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	Q5,13	Transistor, Silicon: NPN; RCA 2N1700 Type	686 082 0	A
18	Q6-7,14,15	Transistor, Germanium: PNP; (2N324 Type Modified)	B686 032 0	C
19	Q8,16	Transistor, Germanium: PNP; General Transistor GT109	B686 069 0	C
20	Q17,18,19,20 21,22	Transistor, Germanium: NPN; 2N169A Type	686 036 0	A
21	R1,27	Resistor, Fixed, Composition: 5.6 Megohms ±10%, ½W; Allen-Bradley EB	626 565 1	A
22	R2,28	Resistor, Fixed, Composition: 3.3K Ohms ±10% ½W; Allen-Bradley EB	626 332 1	A
23	R3,35	Resistor, Fixed, Composition: 1.8K ohms ±10% ½W; Allen-Bradley EB	626 182 1	A
24	R4,36	Resistor, Fixed, Composition: 2.2K ohms ±10% ½W; Allen-Bradley EB	626 222 1	A
25	R5,29	Resistor, Fixed, Composition: 1.6K ohms ±5% ½W; Allen-Bradley EB	626 162 0	A
26	R6,37	Resistor, Fixed, Composition: 8.2K ohms ±5% ½W; Allen-Bradley EB	626 822 0	A
27	R7,30	Resistor, Fixed, Composition: 100 ohms ±10% ½W; Allen-Bradley EB	626 101 1	A
28	R8,31	Resistor, Fixed, Composition: 3.3K ohms ±5% ½W; Allen-Bradley EB	626 332 0	A
29	R9,32	Resistor, Fixed, Composition: 18 ohms ±10% ½W; Allen-Bradley EB	626 180 1	A
30	R10,33	Resistor, Fixed, Composition: 560K ohms ±10% ½W; Allen-Bradley CB	625 564 1	A
31	R11,15,25, 26,34,39,51 52,53,54,59 60	Resistor, Fixed, Composition: 100K ohms ±10% ½W; Allen-Bradley EB	626 104 1	A

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UNIT TITLE
Dual DC Amplifier

MODEL NO.
6.463 Sh 2 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
32	R12,40	Resistor, Fixed, Composition: 33K ohms ±10% ½W; Allen-Bradley EB	626 333 1	A
33	R13,41	Resistor, Fixed, Composition: 5.6K ohms ±5% ½W; Allen-Bradley EB	626 562 0	A
34	R14,38	Resistor, Fixed, Composition: 560K ohms ±10% ½W; Allen-Bradley EB	626 564 1	A
35	R16,17,46, 48	Resistor, Fixed, Composition: 22K ohms ±10% ¼W; Allen-Bradley CB	625 223 1	A
36	R18,50	Resistor, Fixed, Composition: 3.9K ohms ±10% ¼W; Allen-Bradley CB	625 392 1	A
37	R21,22,42, 43	Resistor, Fixed, Composition: 47K ohms ±10% ½W; Allen-Bradley EB	626 473 1	A
38	R23,45	Resistor, Fixed, Composition: 270K ohms ±10% ½W; Allen-Bradley EB	626 274 1	A
39	R55,56	Resistor, Fixed, Composition: 47 Megohms ±10%, ½W; Allen-Bradley EB	626 476 1	A
40	R57,58	Resistor, Fixed, Composition: 150 ohms ±10% ½W; Allen-Bradley EB	626 151 1	A

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UNIT TITLE
Dual DC Amplifier

MODEL NO.
6.463 Sh 3 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Electrolytic: 55 UF +20-15%, 15V; Sprague 109D556C2015F2	516 188 0	B
2	C3,5	Capacitor, Fixed, Ceramic: 100 UUF ± 10% 1000V; Cornell-Dubilier L10T1	515 019 0	A
3	C4,6,20	Capacitor, Fixed, Ceramic: .01 UF +60%-40% 150V; Centralab DDM-103	515 151 0	A
4	C8	Capacitor, Fixed, Electrolytic: 5 UF +20%-15%, 50V; Sprague 109D505C2050C2	516 186 0	B
5	C9,11	Capacitor, Fixed, Electrolytic: 1250 UF +100 10%, 3V; Callins Industries PSS Series	A516 184 0	C
6	C10	Capacitor, Fixed, Electrolytic: 5 UF +100% -10%, 25V; Callins Industries PSS Series	A516 182 0	C
7	C23,27	Capacitor, Fixed, Ceramic: 1,000 UUF GMV, 600V; Cornell-Dubilier BYA601	515 005 0	A
8	C24	Capacitor, Fixed, Ceramic: 2,200 UUF GMV, 1,000V; Cornell-Dubilier BYA10D22	515 006 0	B
9	CR1,2	Diode, Silicon: Pacific Semi-Conductor PS130	614 056 0	B
10	CR3,7-10	Diode, Zener: Silicon;Texas Instrument 1N759	614 091 0	B
11	CR4,5	Rectifier: Silicon; Hughes Semi-Conductors HR10212	614 034 0	B
12	CR6	Diode: Germanium; Clevite CTP462	614 043 0	B
13	D1	Chopper: 6.3V, 60 CPS Coil, BBM, SPDT Contacts; Oak Mfg Co NC600A	530 049 0	C
14	Q1	Transistor, Germanium: PNP; Bendix 2N1136A	686 066 0	B
15	Q2,3,7,12	Transistor, Germanium: PNP; 2N321 Type	686 004 0	A
16	Q5,9,10	Transistor, Germanium: PNP; 2N324 Type	686 005 0	A
17	Q6,11	Transistor, Germanium: PNP; General Transistor, GT109	B686 069 0	C

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UNIT TITLE
Reference Amplifier

MODEL NO.
6.464 Sh 1 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	Q8	Transistor, Germanium: PNP; 2N235A Type	686 034 0	A
19	R1,29,35	Resistor, Fixed, Composition: 22K ohms ±10% ½W; Allen-Bradley EB	626 223 1	A
20	R2	Resistor, Fixed, Composition: 27K ohms ±10% ½W; Allen-Bradley EB	626 273 1	A
21	R3,26,45	Resistor, Fixed, Composition: 2.7K ohms ±10% ½W; Allen-Bradley EB	626 272 1	A
22	R4,7	Resistor, Fixed, Composition: 15K ohms ±10% 1W; Allen-Bradley GB	627 153 1	A
23	R5	Resistor, Fixed, Composition: 1.2K ohms ±10% ½W; Allen-Bradley EB	626 122 1	A
24	R6	Resistor, Variable, Wirewound: 2K ohms ±10% .25W; Bourns 200L-1-202	642 080 0	B
25	R8,22,23, 37	Resistor, Fixed, Composition: 68K ohms ±10% ½W; Allen-Bradley EB	626 683 1	A
26	R9	Resistor, Variable, Wirewound: 10K ohms ±10% .25W; Bourns 200L-1-103	642 082 0	B
27	R10	Resistor, Fixed, Film: 3300 ohms ±1%, ½W; International Resistance Corp DCC Type	634 293 0	B
28	R12	Resistor, Variable, Wirewound: 200 ohms ±5% 1W; Daystrom Pacific Corp 300-00 Type	B642 201 0	B
29	R13	Resistor, Fixed, Composition: 1K ohms ±10% ½W; Allen-Bradley EB	626 102 1	A
30	R15,17,39	Resistor, Fixed, Composition: 4.7K ohms ±10% ½W; Allen-Bradley EB	626 472 1	A
31	R16	Resistor, Fixed, Composition: 3.3K ohms ±10% ½W; Allen-Bradley EB	626 332 1	A
32	R18	Resistor, Fixed, Composition: 12K ohms ±10% ½W; Allen-Bradley EB	626 123 1	A
33	R19	Resistor, Fixed, Composition: 33K ohms ±10% ½W; Allen-Bradley EB	626 333 1	A

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UNIT TITLE
Reference Amplifier

MODEL NO.
6.464 Sh 2 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
34	R20	Resistor, Fixed, Composition: 1.8K ohms ±5% ½W; Allen-Bradley EB	626 182 0	A
35	R21	Resistor, Fixed, Composition: 6.8K ohms ±10% ½W; Allen-Bradley EB	626 682 1	A
36	R24	Resistor, Fixed, Composition: 100 ohms ±10% ½W; Allen-Bradley EB	626 101 1	A
37	R25,38	Resistor, Fixed, Composition: 2.2K ohms ±10% ½W; Allen-Bradley EB	626 222 1	A
38	R27	Resistor, Fixed, Composition: 33 ohms ±10% ½W; Allen-Bradley EB	626 330 1	A
39	R30,34	Resistor, Fixed, Composition: 10K ohms ±10% ½W; Allen-Bradley EB	626 103 1	A
40	R31,36	Resistor, Fixed, Composition: 220 ohms ±10% ½W; Allen-Bradley EB	626 221 1	A
41	R32	Resistor, Fixed, Composition: 120K ohms ±10% ½W; Allen-Bradley EB	626 124 1	A
42	R43	Resistor, Fixed, Film: 500 ohms ±1%, 1/2W; Weston 9852B Type	634 401 0	B
43	R44	Resistor, Fixed, Composition: 15K ohms ±10% ½W; Allen-Bradley EB	626 153 1	A
44	R48	Resistor, Fixed, Composition: 1.8K ohms ±10% ½W; Allen-Bradley EB	626 182 1	A
45	R49	Resistor, Fixed, Composition: 1.2K ohms ±10% 1W; Allen-Bradley GB	627 122 1	A
46	R50	Resistor, Fixed, Film: 22,000 ohms ±1%, ½W; International Resistance Corp., DCC Type	634 296 0	A
47	R52	Resistor, Fixed, Film: 8.2K ohms ±1%, ½W; International Resistance Corp., DCC Type	634 294 0	A
48	R53	Resistor, Fixed, Film: 15,000 ohms ±1%, ½W; International Resistance Corp., DCC Type	634 295 0	A
49	Z1	Oven, Zener	6.210	C

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UNIT TITLE

Reference Amplifier

MODEL NO.

6.464 Sh 3 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1-16	Diode, Silicon: Diodes Inc. DI-51	A614 019 0	C

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UNIT TITLE

Diode Network

MODEL NO.

12.675

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C3,4	Capacitor, Fixed, Ceramic: 3000 PF ±20%, 75V; Glenco Min-K-3000-M	515 149 0	B
2	C5	Capacitor, Fixed, Ceramic: 4700 PF ±20%, 1000 V; Cornell-Dubilier BYA10D47M	515 008 0	A
3	C6,10	Capacitor, Fixed, Ceramic: 1000 PF GMV; 600V; Cornell-Dubilier BYA6D1	515 005 0	A
4	C7	Capacitor, Fixed, Ceramic: 330 PF ±10%, 500V; Erie Resistor Corp. GP2K-330 ±33	515 044 0	A
5	C9	Capacitor, Fixed, Electrolytic: 2 UF +100%-15%, 25V; Sprague TE-1201	516 236 0	A
6	CR1,2,4,5, 8,9,11,12, 14,15	Diode, Germanium: Clevite CTP462	614 043 0	B
7	CR6,10	Diode, Silicon: Continental Device Corp. CD1282	B614 117 0	C
8	CR7,13	Diode, Silicon: Zener; Motorola ½M17Z5	614 118 0	B
9	Q1-4	Transistor, Germanium: PNP; General Electric 2N324 Type	686 005 0	A
10	R1	Resistor, Variable, Wirewound: 500 ohms ±10% .25W; Bourns Laboratories 200P-1-501	642 316 0	B
11	R1p,2p,3p, 4p	Resistor, Fixed, Wirewound, Precision: Value to be determined at time of manufacture	————	—
12	R2,3	Resistor, Variable, Wirewound: 100 ohms ±10% .25W; Bourns Laboratories 200P-1-101	642 314 0	B
13	R4	Resistor, Variable, Wirewound: 50 ohms ±10% .25W; Bourns Laboratories 200P-1-500	642 313 0	B
14	R5	Resistor, Fixed, Composition: 100K ohms ±10% ½W; Allen-Bradley EB	626 104 1	A
15	R6	Resistor, Fixed, Composition: 22K ohms ±10% ½W; Allen-Bradley EB	626 223 1	A

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UNIT TITLE
Network Card

MODEL NO.
12.687 Sh 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
16	R7,10	Resistor, Fixed, Composition: 3.3K ohms ±10% ½W; Allen-Bradley EB	626 332 1	A
17	R8	Resistor, Fixed, Composition: 15K ohms ±10% ½W; Allen-Bradley EB	626 153 1	A
18	R9	Resistor, Fixed, Composition: 68K ohms ±10% ½W; Allen-Bradley EB	626 683 1	A
19	R11	Resistor, Fixed, Composition: 18K ohms ±10% ½W; Allen-Bradley EB	626 183 1	A
20	R12,13,25, 26	Resistor, Fixed, Composition: 10K ohms ±10% ½W; Allen-Bradley EB	626 103 1	A
21	R14	Resistor, Variable, Wirewound: 10 ohms ±10% .25W; Bourns Laboratories 200P-1-100	642 311 0	B
22	R14p	Resistor, Fixed, Wirewound, Precision: 28ohms ±1%, .25W; Resistance Products Co. L-21X Type	Order by Description	C
23	R15	Resistor, Fixed, Wirewound, Precision: 50,000 ohms ±.05%; Julie Research Labs R34 Type	638 046 0	B
24	R16	Resistor, Variable, Wirewound: 20K ohms ±10% .25W; Bourns Laboratories 200P-1-203	642 321 0	B
25	R17	Thermister: 10K ohms ±10% at 25°C; General Electric 1D101	646 031 0	B
26	R18	Resistor, Fixed, Composition: 56 ohms ±10% ½W; Allen-Bradley EB	626 560 1	A
27	R19,21	Resistor, Fixed, Wirewound, Precision (Matched Pair) 2EA 10,000 ohms ±.05%	A638 272 0	C
28	R20	Resistor, Variable, Wirewound: 20 ohms ±10% .25W; Bourns Laboratories 200P-1-200	642 312 0	B
29	R22,23	Resistor, Fixed, Composition: 12K ohms ±10% ½W; Allen-Bradley EB	626 123 1	A
30	R24	Resistor, Fixed, Composition: 56K ohms ±10% ½W; Allen-Bradley EB	626 563 1	A

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UNIT TITLE
Network Card

MODEL NO.
12.687 Sh 2 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Plastic: 1 UF ±20%, 200V Hopkins 1P2M	521 056 0	B
2	C2	Capacitor, Fixed, Electrolytic: 20 UF, 150V Cornell-Dubilier BBR 20-150	516 177 0	A
3	R1	Resistor, Fixed, Wirewound, Precision: 8,964 ohms ±.05%; Julie Research Labs R34 Type	A638 317 0	C
4	R2	Resistor, Fixed, Wirewound, Precision: 100,000 ohms ±.05%; Julie Research Labs R34 Type	A638 316 0	C
5	R3	Resistor, Fixed, Film: 70,000 ohms ±1%, ½W; Weston 9852B	634 355 0	B

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UNIT TITLE

Reference Amplifier Network

MODEL NO.

12,722

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1-1,1-2,2-1,2-2,3-1,3-2,12,14-20	Capacitor, Fixed, Ceramic: 1000 PF GMV; 600V; Cornell-Dubilier BYA6D1	515 005 0	A
2	C4-1,4-2	Capacitor, Fixed, Electrolytic: 4.7 UF ±5% Sprague 150D475X5035BO	516 234 0	A
3	C11	Capacitor, Fixed, Ceramic: 100 PF ±10%, 1000V Cornell-Dubilier L10T1	515 019 0	A
4	C13	Capacitor, Fixed, Ceramic: .01 UF +60%-40% 150V; Centralab DDM-103	515 151 0	A
5	C21	Capacitor, Fixed, Ceramic: 560 PF ±10%, 150V Glenco HC-150-Z-560K	515 167 0	B
6	C22	Capacitor, Fixed, Ceramic: 3000 PF ±20%, 75V Glenco MIN-K-3000	515 149 0	B
7	CR1-28	Diode, Germanium: Clevite CTP462	614 043 0	B
8	Q1-1,1-2,2-1,2-2,3-1,3-2,4-1,4-2,5,6,11,12	Transistor, Germanium: PNP; RCA 2N404 Type	686 048 0	A
9	Q7-10	Transistor, Germanium: PNP; Bendix 2N1008B Type	686 022 0	B
10	R1-1,1-2, R2-1,2-2,22,24	Resistor, Fixed, Composition: 3.3K ohms ±10% ½W; Allen-Bradley EB	626 332 1	A
11	R3-1,3-2,4-1,4-2,9-1,9-2,43,44	Resistor, Fixed, Composition: 15K ohms ±10% ½W; Allen-Bradley EB	626 153 1	A
12	R5-1,5-2,6-1,6-2,11-1,11-2,45,46	Resistor, Fixed, Composition: 100K ohms ±10% ½W; Allen-Bradley EB	626 104 1	A
13	R7,8	Resistor, Fixed, Composition: 4.7K ohms ±10% ½W; Allen-Bradley EB	626 472 1	A

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UNIT TITLE
Automatic Range Switching Circuits

MODEL NO.
14.115 Sh 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
14	R10	Resistor, Fixed, Composition: 22K ohms ±5% ½W; Allen-Bradley Eb	626 223 0	A
15	R21	Resistor, Fixed, Composition: 22K ohms ±10% ½W; Allen-Bradley Eb	626 223 1	A
16	R23,27,33-40	Resistor, Fixed, Composition: 10K ohms ±10% ½W; Allen-Bradley Eb	626 103 1	A
17	R25	Resistor, Fixed, Composition: 8.2K ohms ±10% ½W; Allen-Bradley EB	626 822 1	A
18	R26	Resistor, Fixed, Composition: 47 K ohms ±10% ½W; Allen-Bradley EB	626 473 1	A
19	R28,29,30,42	Resistor, Fixed, Composition: 3.9K ohms ±10% ½W; Allen-Bradley EB	626 392 1	A
20	R31	Resistor, Fixed, Composition: 1.2K ohms ±10% ½W; Allen-Bradley EB	626 122 1	A
21	R32	Resistor, Fixed, Wirewound: 4.7 ohms ±10% 1W; International Resistance Co.BW-1 Type	636 118 0	A
22	R41	Resistor, Fixed, Composition: 2.7K ohms ±10% ½W; Allen-Bradley EB	626 272 1	A

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UNIT TITLE
Automatic Range Switching Circuits

MODEL NO.
14.115 Sh2 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR3,5,7,9, 11 Thru 35	Rectifier, Silicon: Hughes Semi-Conductors HD6226	614 034 0	B
2	CR4,6,8,10, 36	Diode, Silicon: 1N459 Type	614 007 0	A
3	HR1,2	Resistor, Heat Pad: Electro-Flex Heat Inc, 1388	646 022 0	B
4	P1	Connector, Plug: 50 Cntacts: Cannon Electric DD50P	542 102 0	A
5	R1	Resistor, Fixed, Film: 56K Ohms ± 1%, 1/2W; Aerovox CPX-1/2	634 010 0	A
6	S1	Switch, Thermostat: Fenwall 32410-2	B 662 018 0	B
		COMPARATOR AMPLIFIER 26.134-2		
1	C1	Capacitor, Fixed, Ceramic: 560 UUF ± 10%, 500V; Erie Resistor Corp GP2K-560±56	515 047 0	A
2	CR1	Diode, Germanium: Clevite CTP462	614 043 0	B
3	Q1,2	Transistor, Germanium: PNP; 2N345 Type	686 006 0	B
4	Q3,4,5	Transistor, Germanium: PNP; 2N404 Type	686 048 0	A
5	R1	Resistor, Fixed, Film: 190K Ohms ± 1%, 1/2W; Aerovox CPX-1/2	634 019 0	B
6	R2,4	Resistor, Fixed, Composition: 1.8K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 182 1	A
7	R3	Resistor, Fixed, Composition: 220 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 221 1	A
8	R5	Resistor, Fixed, Composition: 2.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 272 1	A
9	R6,7,8	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
10	R9,10	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A

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UNIT TITLE
COMPARATOR AND DIODE GATE

MODEL NO.
26.096-1

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	R1	Resistor, Fixed, Wirewound, Precision: 1,249,685 Ohms ± .1%	A638 460 0	C
2	R2	Resistor, Fixed, Film: 12.5 Megohms ± 1%, 2W; Aerovox CPX-2	634 225 0	A
3	R3	Resistor, Fixed, Film: 2.5 Megohms ± 1%, 1/2W; Aerovox CPX-1/2	634 187 0	A
4	R4	Resistor, Fixed, Film: 25 Megohms ± 1%, 2W; Aerovox CPX-2	634 189 0	A
5	R5	Resistor, Fixed, Film: 5 Megohms ± 1%,. 1/2W; Aerovox CPX-1/2	634 034 0	A
6	R6	Resistor, Fixed, Film: 50 Megohms ± 1%, 2W; Aerovox CPX-2	634 190 0	A
7	R7	Resistor, Fixed, Film: 10 Megohms ± 1%, 1W; Aerovox CPX-1	634 053 0	A
8	R8	Resistor, Fixed, Film: 100 Megohms ± 2%, 2W; Aerovox CPX-2	634 191 0	A
9	R9	Resistor, Fixed, Wirewound, Precision: 12,442 Ohms ± .05%	A638 452 0	C
10	R9p	Resistor, Variable, Wirewound: 50 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 435 0	B
11	R10	Resistor, Fixed, Wirewound, Precision: 124,586 Ohms ± .05%	A638 456 0	C
12	R10p,15p	Resistor, Variable, Wirewound: 500 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 438 0	B
13	R11	Resistor, Fixed, Wirewound, Precision: 24,896 Ohms ± .05%	B638 453 0	C
14	R11p	Resistor, Variable, Wirewound: 100 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	B642 436 0	B
15	R12	Resistor, Fixed, Wirewound, Precision: 249,749 Ohms ± .05%	A638 457 0	C
16	R13	Resistor, Fixed, Wirewound, Precision: 49,811 Ohms ± .05%	A638 454 0	C
17	R13p	Resistor,Variable, Wirewound: 200 Ohms ± 5%, 1W; Daystrom-Pacific Model 301-60	A642 437 0	B

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UNIT TITLE
SUMMING RESISTOR NETWORK

MODEL NO.
26.116 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R14	Resistor, Fixed, Wirewound, Precision: 499,648 Ohms ± .05%	A638 458 0	C
19	R15	Resistor, Fixed, Wirewound, Precision: 99,609 Ohms ± .05%	A638 455 0	C
20	R16	Resistor, Fixed, Wirewound, Precision: 999,598 Ohms ± .05%	A638 459 0	C
21	R17,18	Resistor, Fixed, Wirewound, Precision(Matched Pair): Total Series Resistance to be 1,253 Ohms ± .05%	A638 540 0	C
22	R19	Resistor, Fixed, Composition: 12 Megohms ± 10%, 1/2W' Allen-Bradley EB	626 126 1	A

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UNIT TITLE
SUMMING RESISTOR NETWORK

MODEL NO.
26.116 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,6,9,12	Capacitor, Fixed, Electrolytic: 55 UF +20% -15%, 50V; Sprague 109D556C2050T2	516 237 0	A
2	C2,7,10	Capacitor, Fixed, Electrolytic: 10UF +100% -15%, 15V; Sprague TE-1155	516 238 0	A
3	C3,8,11	Capacitor, Fixed, Electrolytic: 50 UF +100% -15%, 25V; Sprague TE-1209	516 149 0	A
4	C4,13	Capacitor, Fixed, Electrolytic: 30 UF +100% -15%, 15V; Sprague TE-1158	516 039 0	A
5	C5	Capacitor, Fixed, Electrolytic: 110 UF +100% -15%, 3V; Sprague TE-1060	516 043 0	A
6	CR1,3,4	Diode, Silicon: Zener; Texas Instruments 1N754A Type	614 046 1	B
7	CR2,5	Diode, Silicon: Hughes Semi-Conductors HD6403	B614 096 1	C
8	Q1,6,8	Transistor, Germanium: PNP; Motorola 2N652 Type	686 084 0	B
9	Q2,7,9	Transistor, Germanium: PNP; RCA 2N404 Type	686 048 0	A
10	Q3,4,5	Transistor, Germanium: PNP; General Electric 2N321 Type	686 004 0	A
11	R1,2,13,14 20,21	Resistor, Fixed, Composition: 4.7K ohms ±10% ½W; Allen-Bradley EB	626 472 1	A
12	R3,15,22	Resistor, Fixed, Composition: 8.2K ohms ±10% ½W; Allen-Bradley EB	626 822 1	A
13	R4,16,23, 29,30,31	Resistor, Fixed, Composition: 1K ohms ±10% ½W; Allen-Bradley EB	626 102 1	A
14	R6,18,25	Resistor, Variable, Wirewound: 200 Ohms ±10% 1W; Bourns Laboratories 260P-1-201	642 327 0	B
15	R7,19,26	Resistor, Fixed, Composition: 560 ohms ±10% ½W; Allen-Bradley EB	626 561 1	A
16	R8	Resistor, Fixed, Composition: 680 ohms ±5% ½W; Allen-Bradley	626 681 0	A

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UNIT TITLE

Power Supply Regulator

MODEL NO.

43.094 Sh 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	R9	Resistor, Fixed, Composition: 300 ohms ±5% ½W; Allen-Bradley EB	626 301 0	A
18	R11	Resistor, Fixed, Composition: 1.1K ohms ±5% ½W; Allen-Bradley EB	626 112 0	A
19	R12	Resistor, Fixed, Composition: 200 ohms ±5% ½W; Allen-Bradley EB	626 201 0	A
20	R27	Resistor, Fixed, Composition: 2K ohms ±10% ½W; Allen-Bradley EB	626 202 1	A

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UNIT TITLE

Power Supply Regulator

MODEL NO.

43.094 Sh 2 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,4,5 Thru 22	Capacitor, Fixed, Ceramic: 1000 UUF ± 10%, 75V; Glenco Min-Z-1000-K	515 145 0	B
2	C2,3	Capacitor, Fixed, Ceramic: 3000 UUF ± 20%, 75V; Glenco Min-K-3000-M	515 149 0	B
3	CR1 Thru 21	Diode, Germanium: Clevite CTP462	614 043 0	B
4	Q1 Thru 12	Transistor, Germanium: PNP;(2N324 Type Mod.)	B686 032 0	C
5	R1,2	Resistor, Fixed, Composition: 4.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 472 1	A
6	R3,9,12,17, 19,23,26, 31,35,39,43	Resistor, Fixed, Composition: 15K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 153 1	A
7	R4,10,13,18, 20,24,27,32, 40,44	Resistor, Fixed, Composition: 100K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 104 1	A
8	R5,8,11,14, 25,33,37,38, 47 Thru 52	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
9	R6,7,15,16, 21,22,29,30, 41,42	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
10	R34,36,45	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A

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UNIT TITLE
BINARY CODED DECADE COUNTER

MODEL NO.
44.139-1

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Ceramic: 220 UUF ± 10%, 600V; Cornell-Dubilier LA-S3	515 020 0	B
2	C2,4 Thru 11, 13 Thru 16	Capacitor, Fixed, Ceramic: 1000 UUF ± 10%, 75V; Glenco Min-Z-1000-K	515 145 0	B
3	C3	Capacitor, Fixed, Ceramic: 5600 UUF GMV, 600V; Centralab D6-562	515 179 0	B
4	C12	Capacitor, Fixed, Ceramic: .47 UF ± 20%, 25V; Sprague 5C11	515 190 0	B
5	CR1 Thru 11 13	Diode, Germanium: Clevite CTP462	614 043 0	B
6	L1	Coil: 3.3 MH ± 10%; Essex WEE-3300	538 009 0	C
7	Q1 Thru Q14	Transistor, Germanium: PNP;(2N324 Type Mod.)	B 686 032 0	C
8	R1,5,16,17, 18,29,42, 43,52	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
9	R2	Resistor, Fixed, Composition: 1.5K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 152 1	A
10	R3,7,36	Resistor, Fixed, Composition: 470 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 471 1	A
11	R4,34,38	Resistor, Fixed, Composition: 1K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 102 1	A
12	R6	Resistor, Fixed, Composition: 270K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 274 1	A
13	R9,10,14, 19,23,27, 32,46,47, 50,53	Resistor, Fixed, Composition: 15K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 153 1	A
14	R11,15,20, 24,25,28, 33,39,48,49	Resistor, Fixed, Composition: 100K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 104 1	A
15	R12,13	Resistor, Fixed, Composition: 820 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 821 1	A
16	R21,22,30, 31,44,45	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A

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UNIT TITLE
PROGRAMMER

MODEL NO.
44.170-3 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	R26	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A
18	R51	Resistor, Fixed, Composition: 470K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 474 1	A
19	T1	Transformer, Pulse: Technitrol CB1JA (395.7)	A684 091 0	C

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UNIT TITLE
PROGRAMMER

MODEL NO.
44.170-3 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1 Thru CR38	Diode, Germanium: Clevite CTP462	614 043 0	B
2	Q1 Thru Q10	Transistor, Germanium: PNP; 2N321 Type	686 004 0	A
3	Q11 Thru Q18	Transistor, Germanium: PNP ; (2N324 Type Modified)	B686 032 0	C
4	R1 Thru R10	Resistor, Fixed, Composition: 1.2K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 122 1	A
5	R11,17,19, 25,26,33, 34,41	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A
6	R13,16,21, 24,29,32, 37,40	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
7	R12,14,15, 18,20,22, 23,27,28, 30,31,35, 36,38,39, 42	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
8	R43	Resistor, Fixed, Wirewound: 4.7 Ohms ± 10%, 1/2W; International Resistance Co. Type BW 1/2	636 172 0	B

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UNIT TITLE
READOUT STORAGE DECADE

MODEL NO.
51.010-1

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1-56,59-62	Diode, Germanium: Clevite CTP 462 Type	614 043 0	B
2	CR63	Rectifier, Silicon: Hughes Semi-Conductors HR10212 Type	614 034 0	B
3	Q1-10	Transistor, Germanium: PNP; Industro	B686 032 0	C
4	Q11-22	Transistor, Germanium: PNP; General Electric ZN321 Type	686 004 0	A
5	R1,2,9,10, 17,18,25, 26,40,52, 53	Resistor, Fixed, Composition: 3.3K ohms ±10% ½W; Allen-Bradley EB	626 332 1	A
6	R3-6,11-14, 19-22,27-30,54	Resistor, Fixed, Composition: 10K ohms ±10% ½W; Allen-Bradley EB	626 103 1	A
7	R7,8,15,16, 23,24,31,32	Resistor, Fixed, Composition: 22K ohms ±10% ½W; Allen-Bradley EB	626 223 1	A
8	R33-39,41-48,56	Resistor, Fixed, Composition: 1.2K ohms ±10% ½W; Allen-Bradley EB	626 122 1	A
9	R49	Resistor, Fixed, Composition: 2.7 ohms ±10% 1W; Allen-Bradley EB	627 279 1	A
10	R50,51,55	Resistor, Fixed, Composition: 5.6K ohms ±10% ½W; Allen-Bradley EB	626 562 1	A

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UNIT TITLE
Readout Storage Decade

MODEL NO.
51.080-1

APPENDIX II

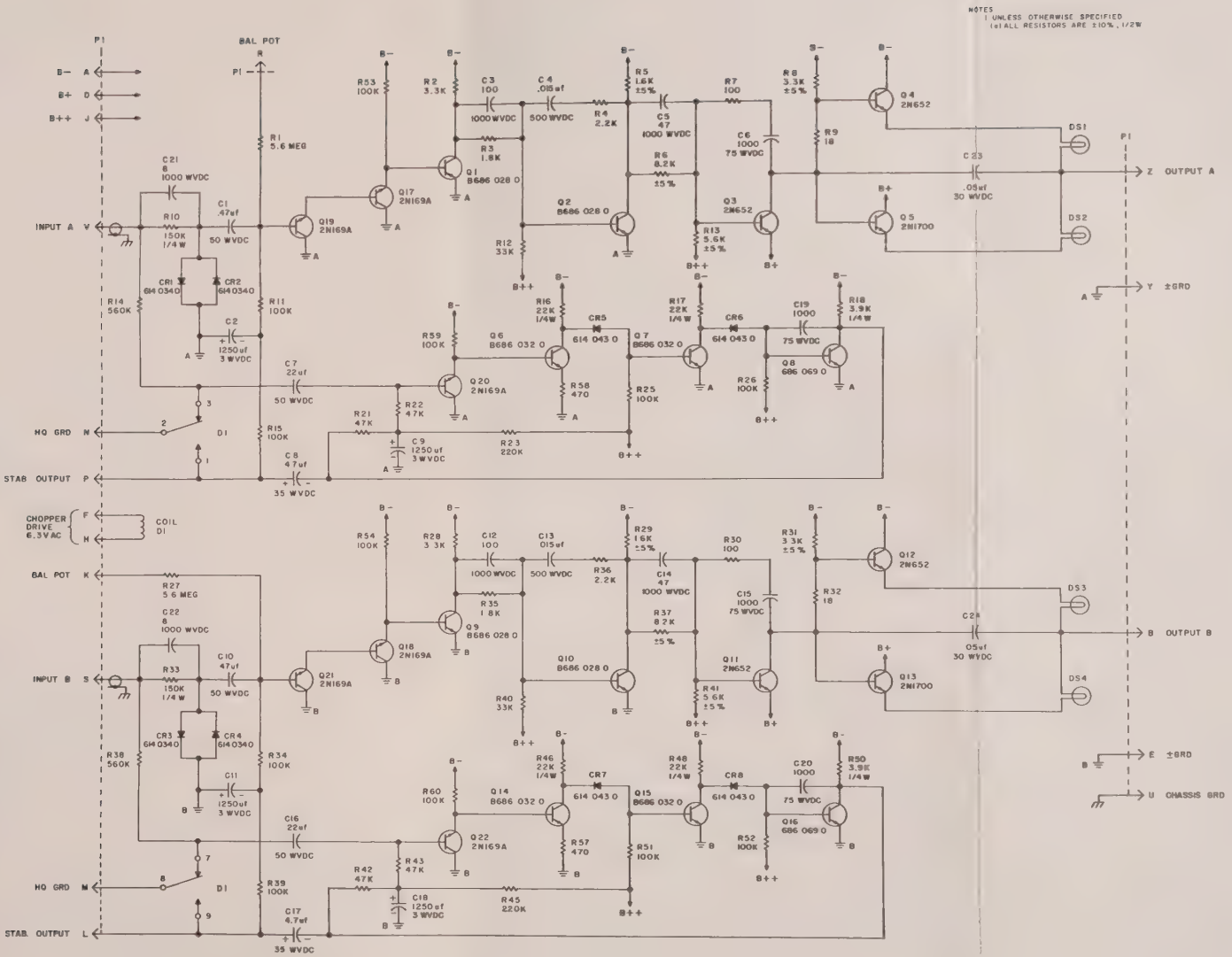
DRAWINGS

This appendix contains necessary schematic and wiring diagrams for the 5001 Transistorized Digital Voltmeter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawing, and the associated drawing number. The drawings are bound into the manual in the order listed under the index drawing number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards. Unless otherwise specified, all resistance values are given in ohms and capacitance values in micro-micro farads (mmf).

INDEX

UNIT OR COMPONENT	TYPE OF DRAWING	DRAWING NUMBER
6.463 Dual D.C. Amplifier	Schematic	D006 463 0S
6.464 Reference Amplifier	Schematic	D006 464 0S
12.687 Network Card	Schematic	C012 687 0S
14.115 Automatic Range Switching Circuits	Schematic	D014 115 0S
26.096-1 Comparator Amplifier and Diode Gate	Schematic	C026 096 0S
26.134-2 Comparator Amplifier	Schematic	C026 134 0S
Model 26.158, 5001 TDVM	Schematic	D026 158 0S (Sheets 1 through 4)
	Wiring	D026 158 0W (Sheets 2 through 32)
43.094 Power Supply Regulator	Schematic	C043 094 0S
44.139-1 and 44.139-5 Binary Coded Decade Counter	Schematic	D044 139 0S
44.170-3 Programmer	Schematic	D044 170 0S
51.010-1 Readout Storage Decade	Schematic	D051 010 0S
51.080-1 Readout Storage Decade	Schematic	D051 080 0S

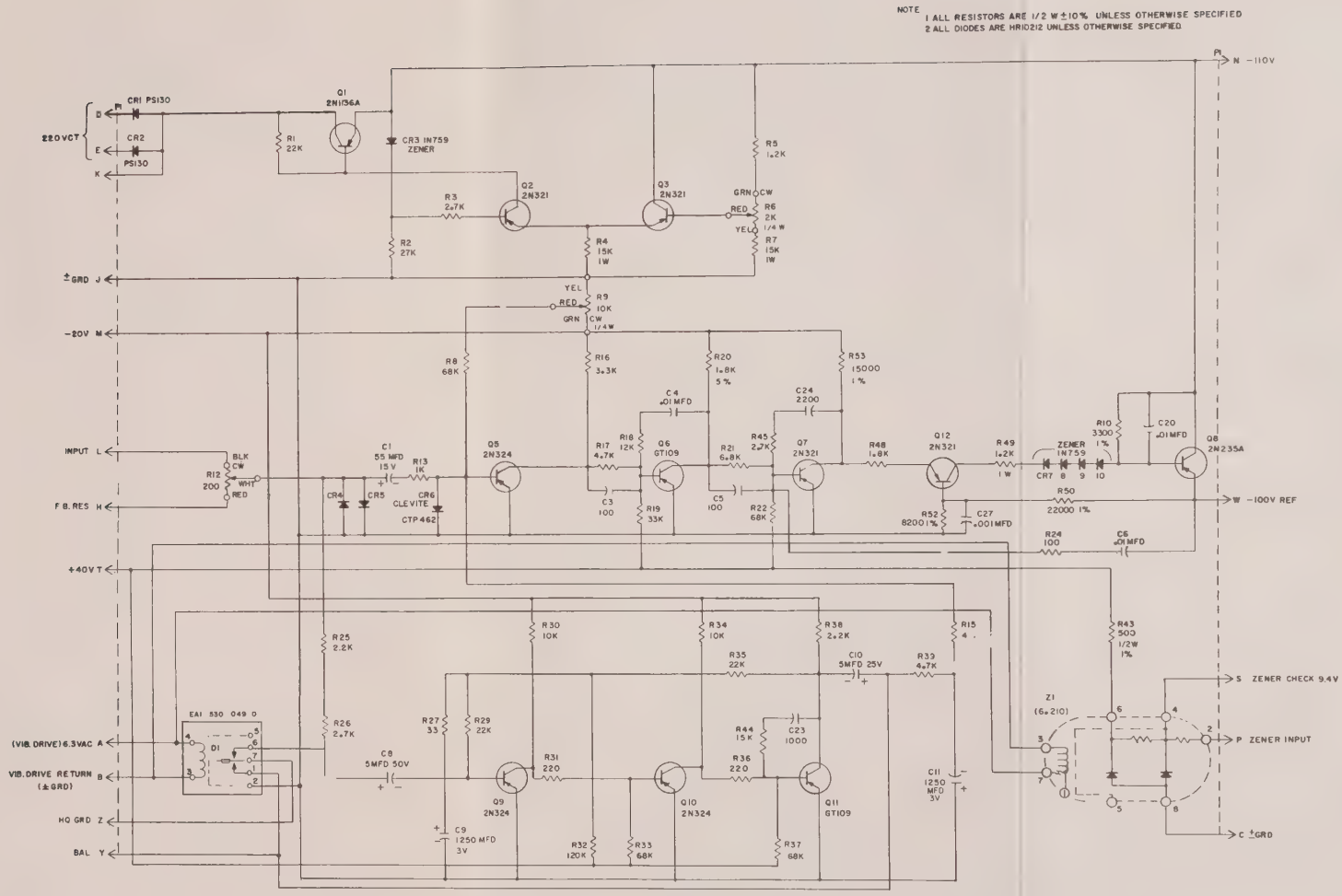


ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

SCHEMATIC
DUAL D.C. AMPLIFIER
(SERIES 5001 TDVM)

ENT NO.	
SIZE	
REV NO.	
PROJECT 1887	D006 463 0S

SHEET 1 OF 1 SHEETS



ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

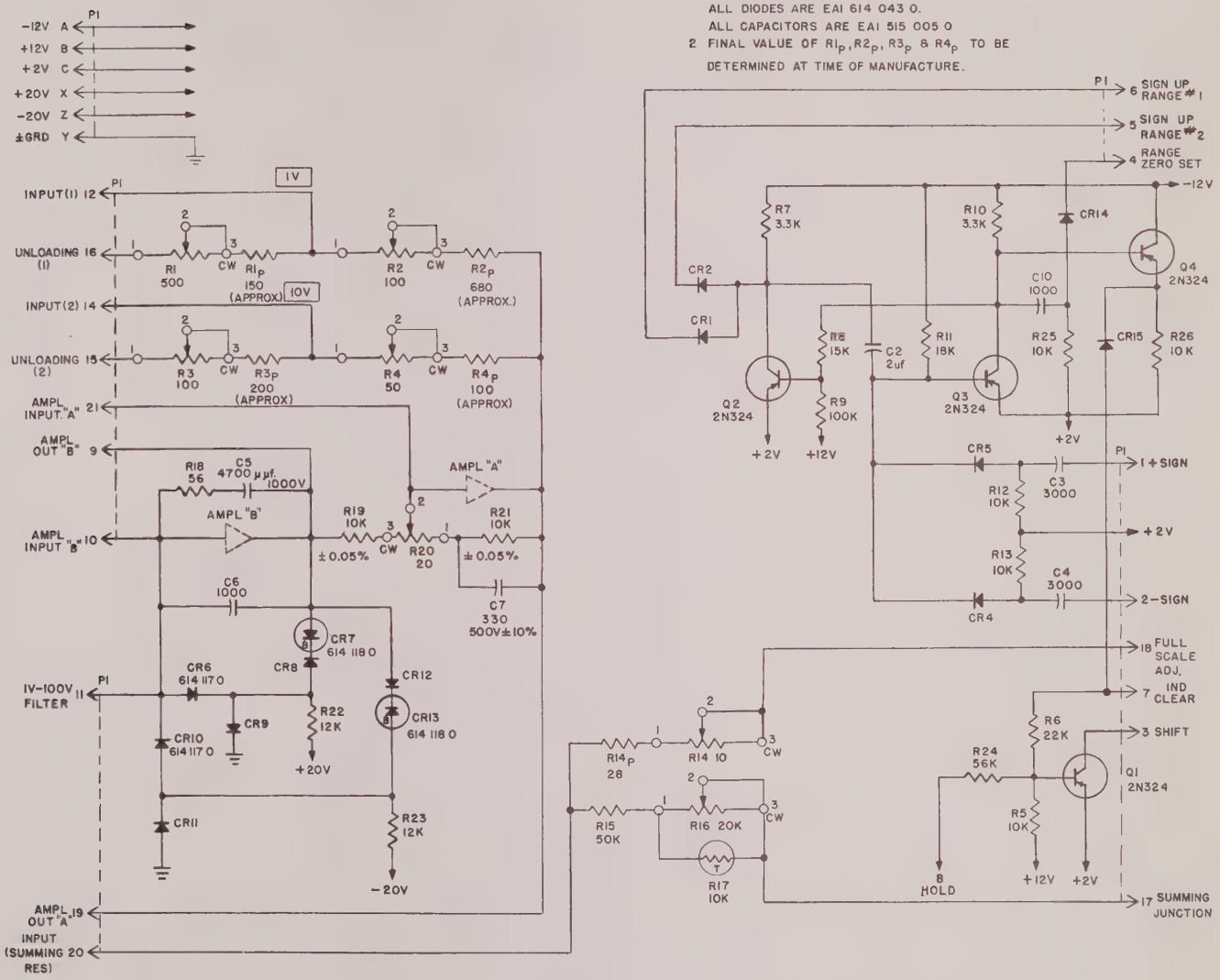
SCHEMATIC

REFERENCE AMPLIFIER
(SERIES 5001 TDVM)

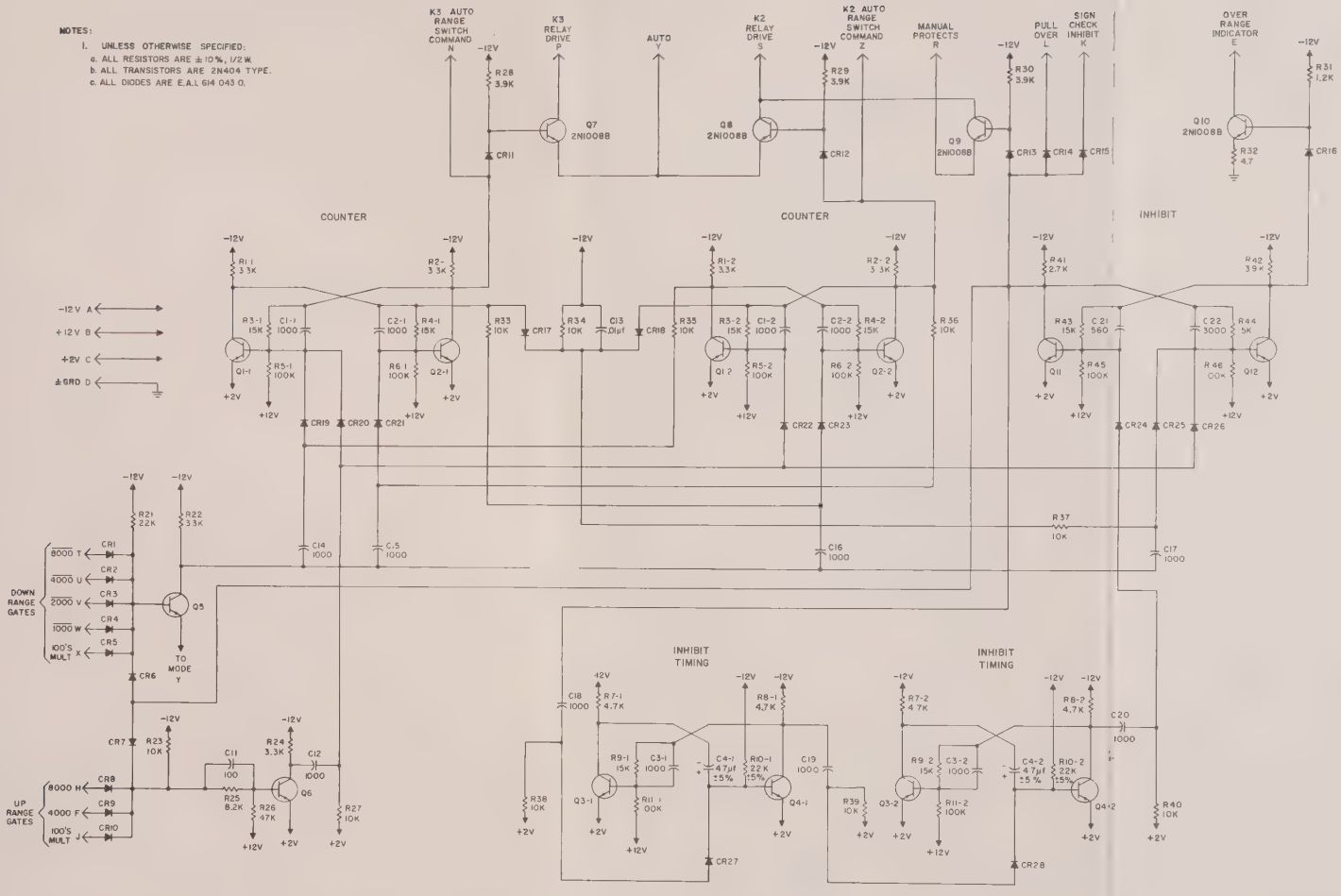
PROJECT	1887
	D006 464 0S

NOTE

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE ±10% TOL., 1/2W
   ALL DIODES ARE EAI 614 043 0.
   ALL CAPACITORS ARE EAI 515 005 0
2. FINAL VALUE OF $R1_P$, $R2_P$, $R3_P$ & $R4_P$ TO BE DETERMINED AT TIME OF MANUFACTURE.

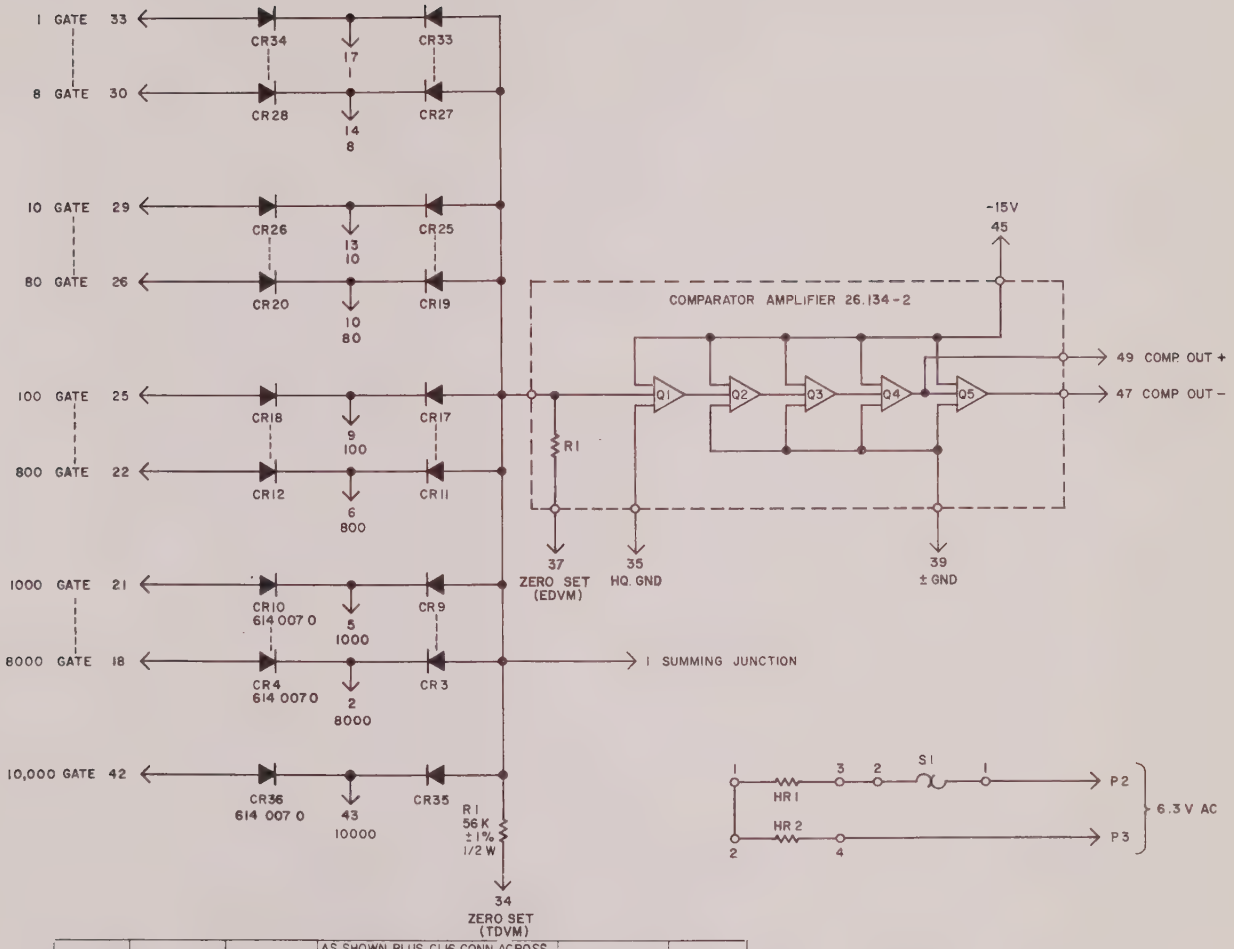


ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC MISC. NETWORK CARD (SERIES 5001 TDVM)	
SHT NO	
SIZE	
REV NO	
PROJECT 1887	C012 687 0S
SHEET / OF / SHEETS	



ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY.
SCHEMATIC
AUTO. RANGE SW. CKT.
(SERIES 5001 TDVM)
SHT NO
SIZE
REV NO
PROJECT
1887 D014 115 OS
SHEET 1 OF 1 SHEETS

NOTES
1. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 614 034 0
2. UNLESS OTHERWISE SPECIFIED ALL CONN PINS REF TO P1



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
26 096-2	026 096 2S	026 096 2P	AS SHOWN PLUS C1 IS CONN. ACROSS CR 34 & C2 IS CONN. ACROSS CR 32	A026 156 0P	1423
26.096-1	026 096 1S	026 096 1P	AS SHOWN	A026 045 0P	1969
26,096	C026 096 0S	A026 096 0P	USE COMP AMPL. 26.134-0	——	1969

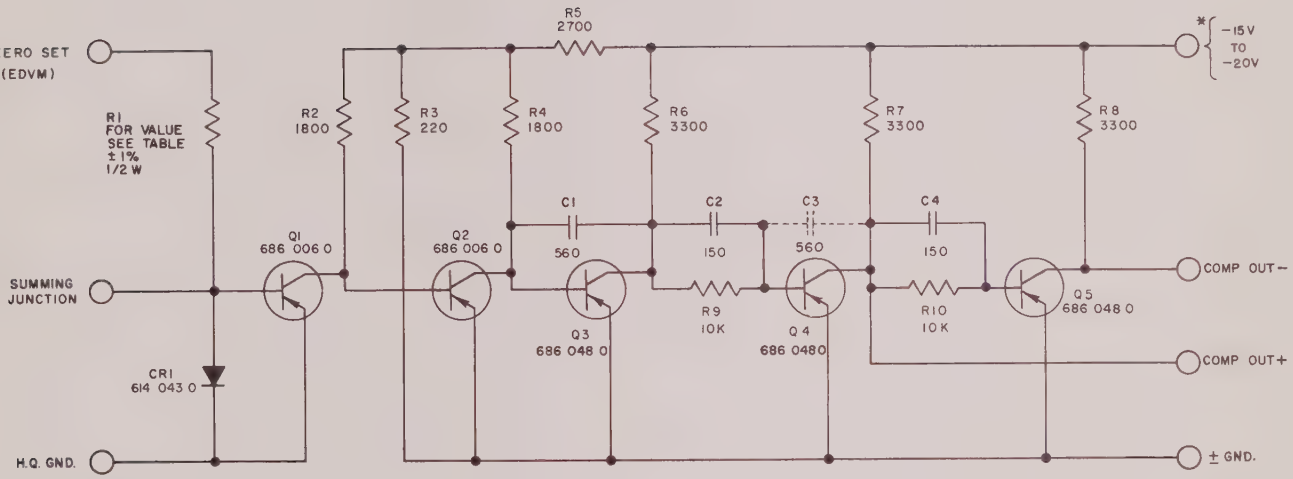
TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC. LONG BRANCH NEW JERSEY	
SCHEMATIC COMPARATOR & DIODE GATE	
SHT NO	
SIZE	
REV NO	
PROJECT 1969	C026 096 0S
SHEET	OF SHEETS

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE ± 10% TOLERANCE, 1/2 W.
2. C3 SHOWN FOR REFERENCE ONLY. IT IS NOT USED IN PRESENT DESIGN
3. ON THE TERMINAL DESIGNATED BY (*) THE VOLTAGE APPLIED DEPENDS ON THE EXTERNAL POWER SUPPLY USED.

3



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
26 134-2	026 134 2S	026 134 2P	LESS C2 & C4, R1 TO BE 190K	026 096 1P	1969
26.134-1	026 134 1S	026 134 1P	LESS C1, R1 TO BE 56K	———	———
26.134	C026 134 0S	A026 134 0P	LESS C2 & C4, R1 TO BE 56K	A026 096 0P	1969

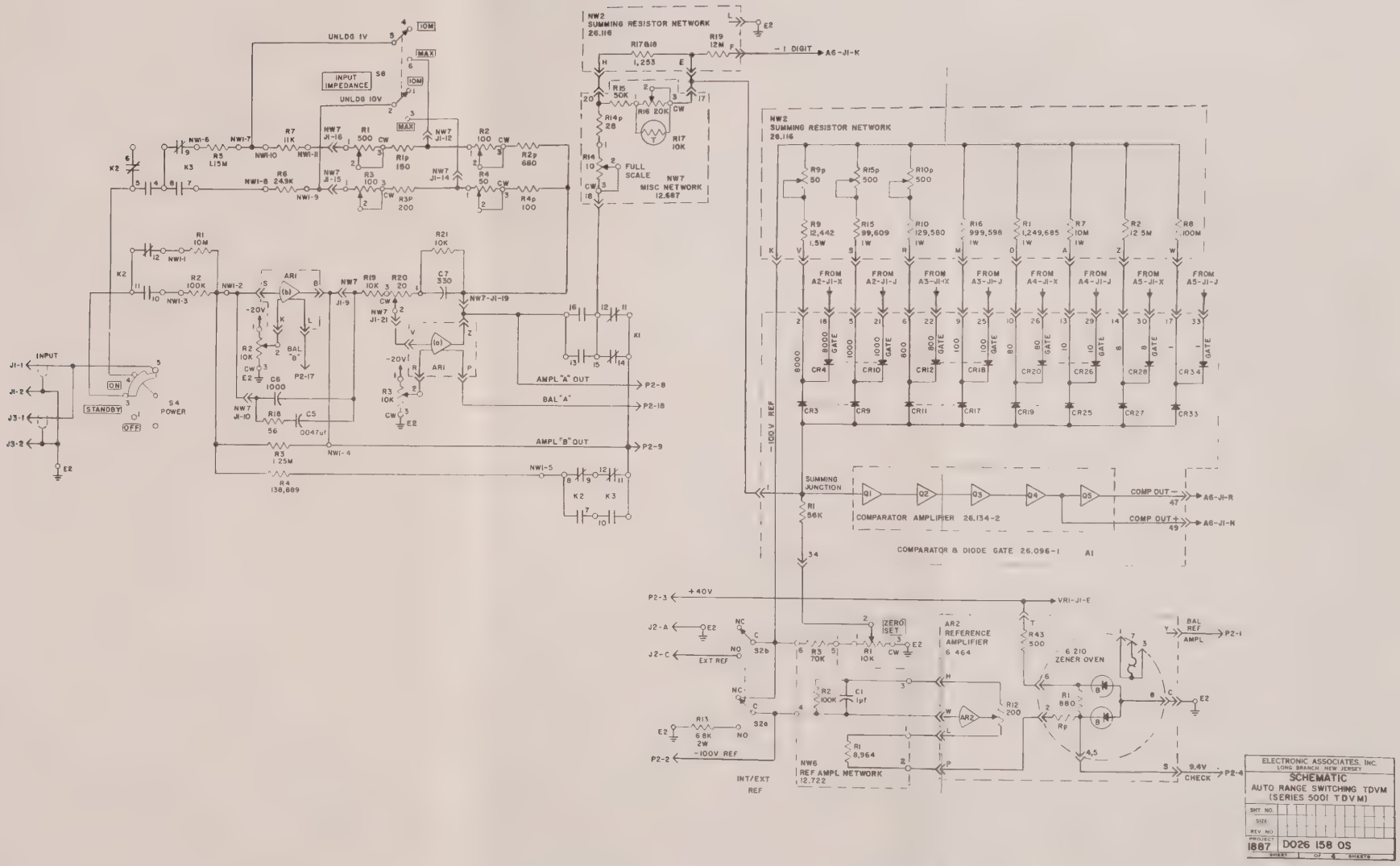
TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

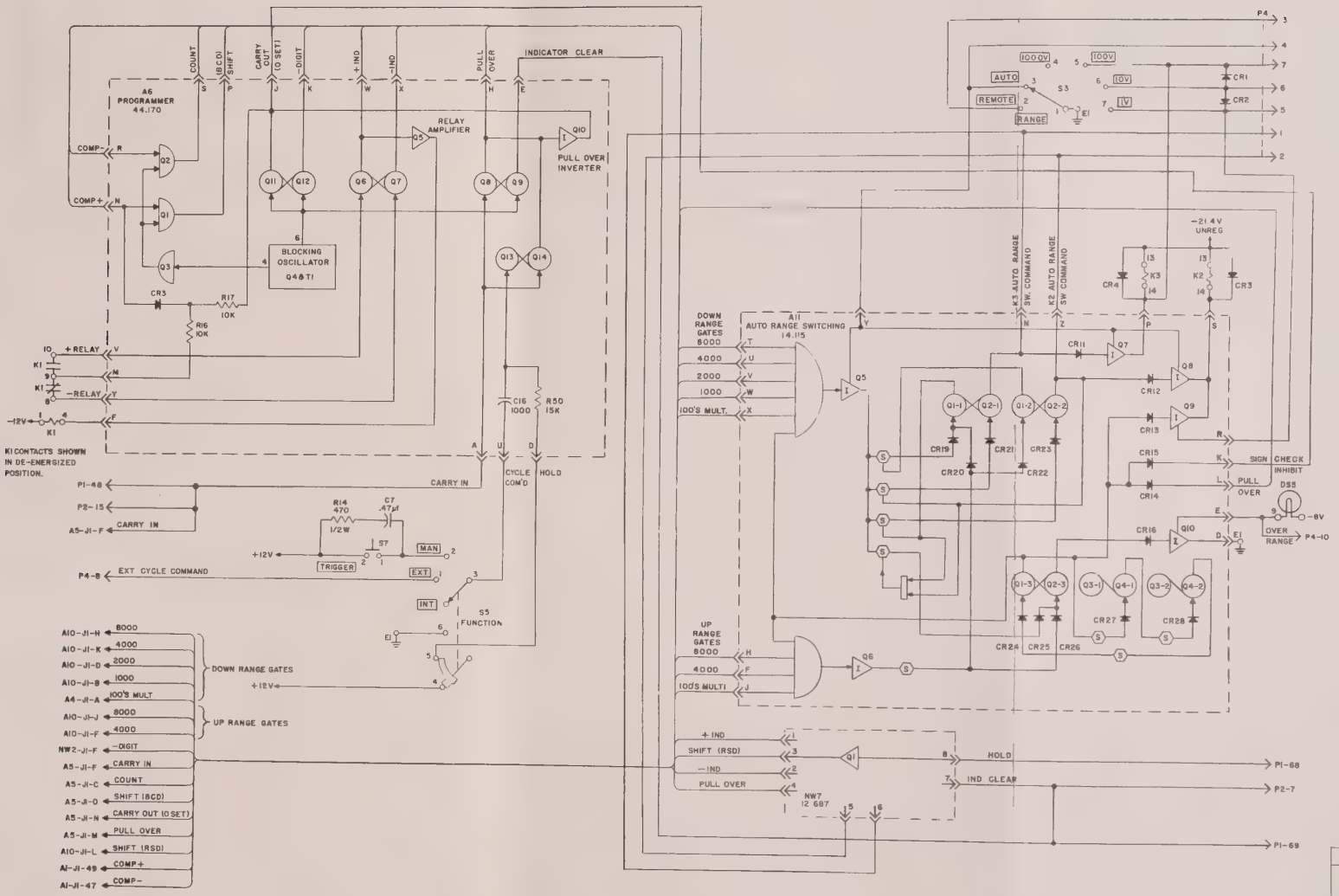
SCHEMATIC DIAGRAM
COMPARATOR AMPLIFIER

SHT. NO.	
SIZE	
REV NO.	
PROJECT	1969 C026 134 0S

SHEET / OF SHEETS

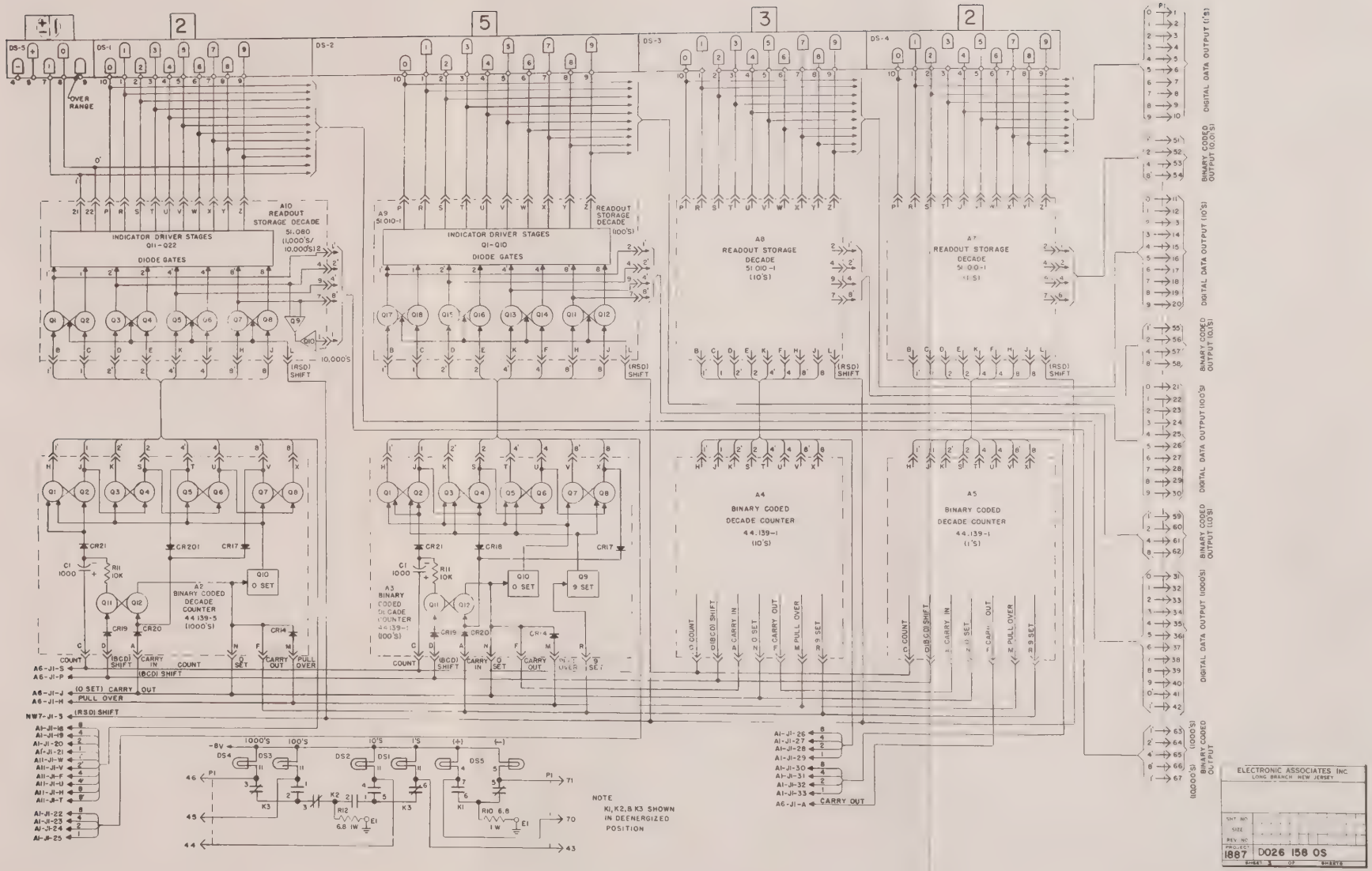


ELECTRONIC ASSOCIATES, INC.	LONG BRANCH, NEW JERSEY
SCHEMATIC	
AUTO RANGE SWITCHING TDVM (SERIES 5001 TDVM)	
SMT NO.	
SIZE	
REV NO	
PROJECT 1887	D026 158 05
SHEET	OF 4 SHEETS



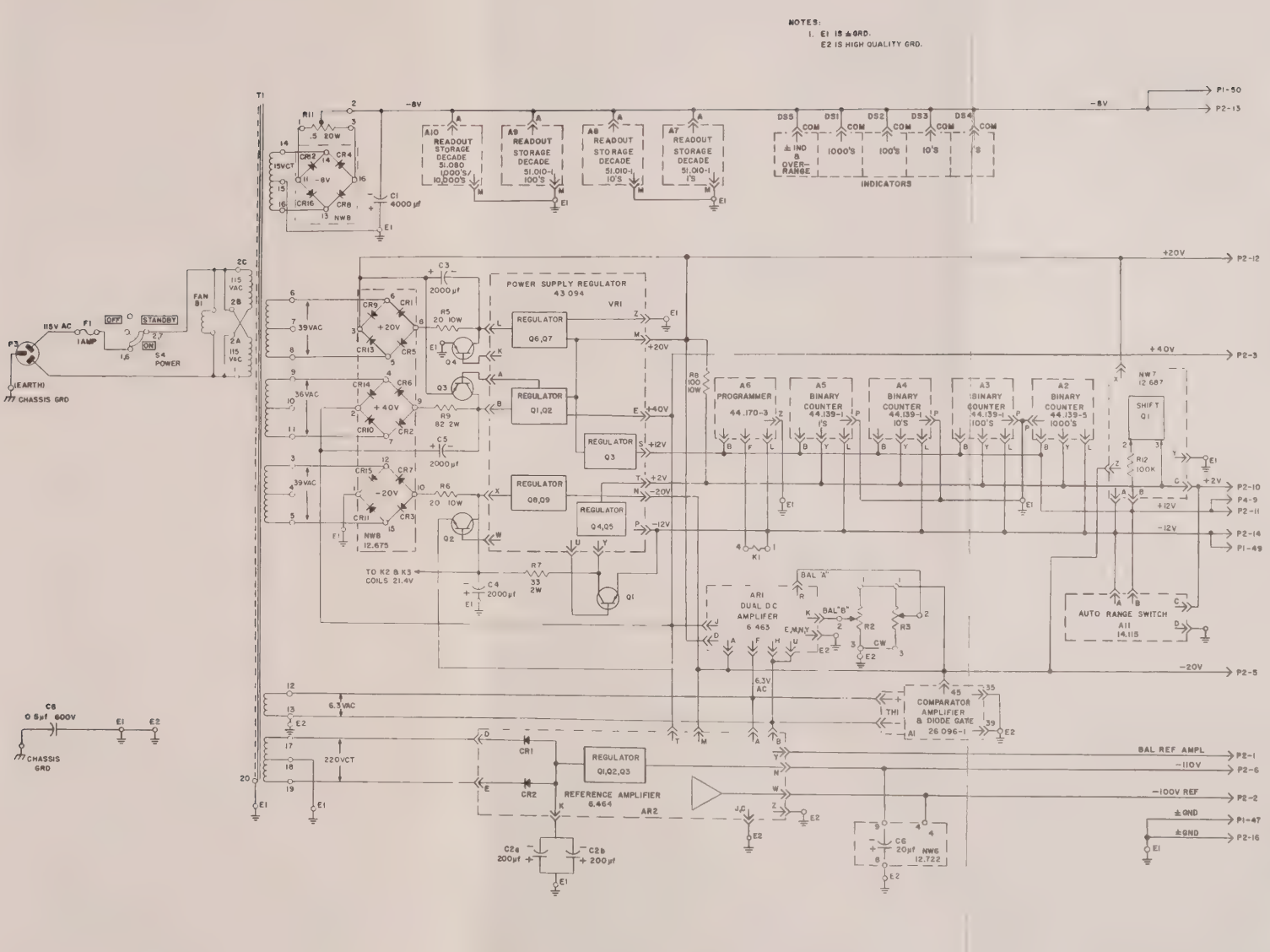
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

SHT NO.
SIZE
REV. NO.
PROJECT 1887 DD26 158 OS
SHEET X OF SHEETS



ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY

UNIT NO.	
SIZE	
REV NO.	
PROJECT	1887 D026 158 0S
SHEET 3 OF	SHEETS

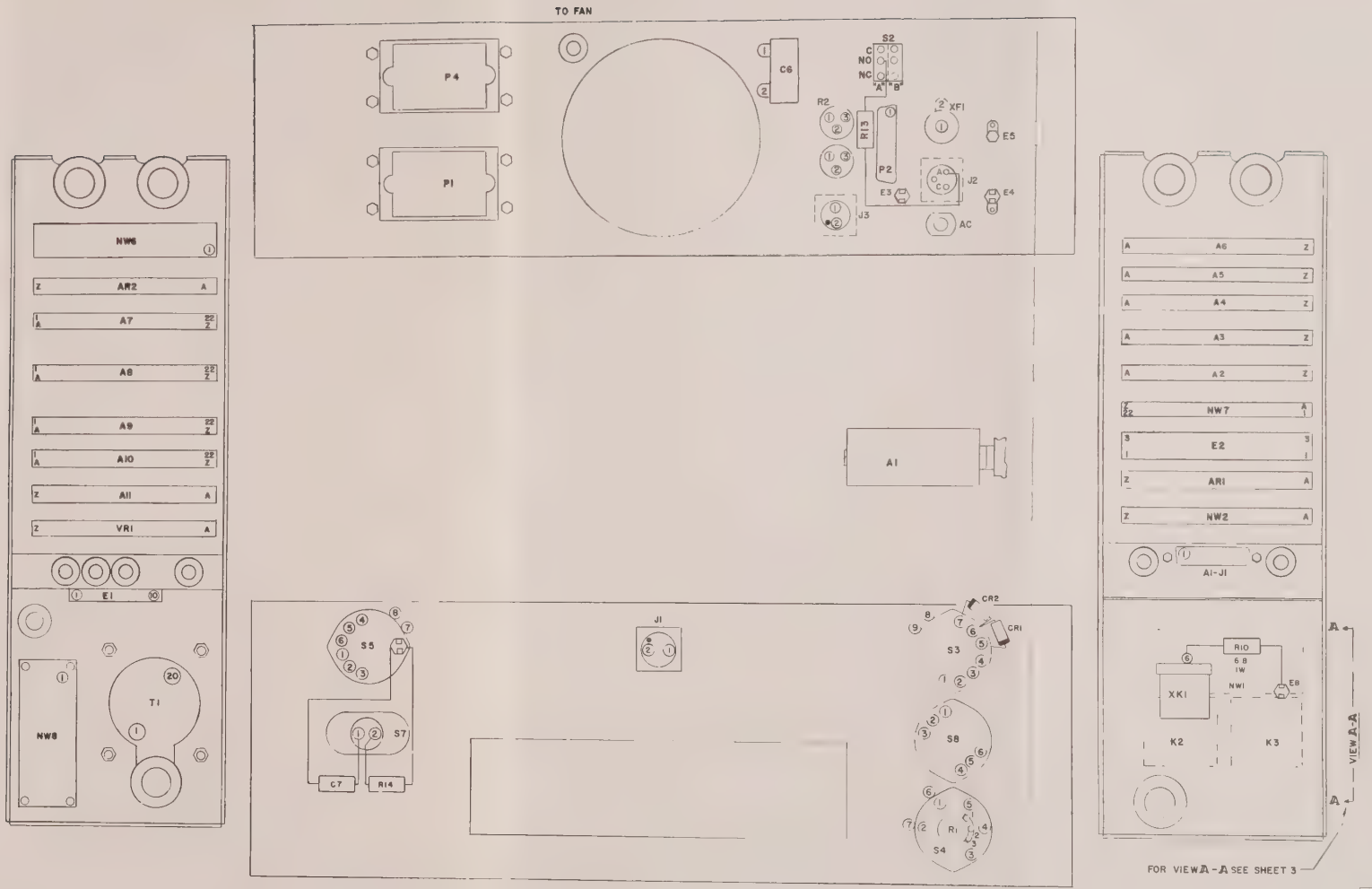


ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO	SIZE	REV. NO.	PROJECT
			1887

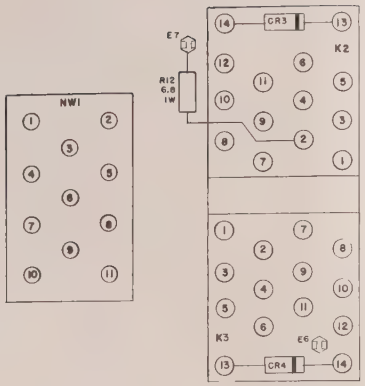
D026 158 0S

SHEET OF SHEETS

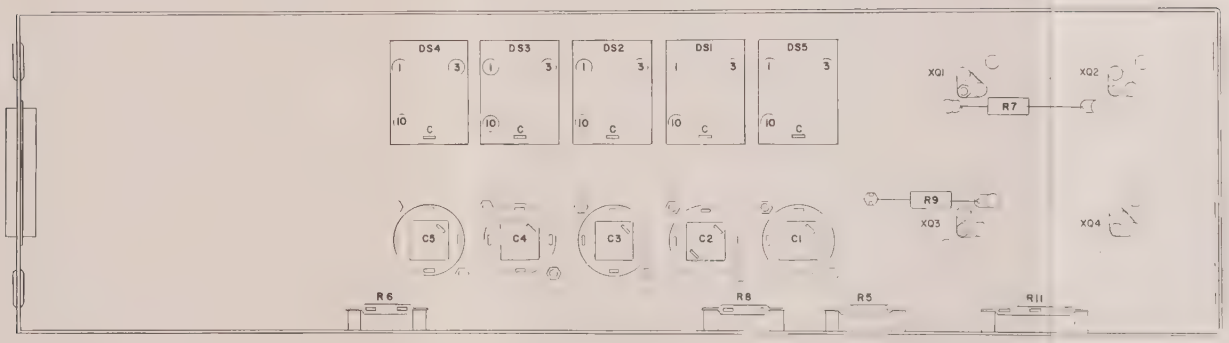


ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY

SHT NO
SIZE
REV NO
PROJECT 1887 D026 158 OW
SHEET OF SHEETS



VIEW A-A



ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY

SHT NO
SIZE
REV NO
PROJECT 1887 D026 158 OW
SHEET OF SHEETS

AR1-J1 DUAL DC AMPLIFIER 6.463 and AR2-J1 REFERENCE AMPLIFIER 6.464						
HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1		COLUMN 2	
			DESTINATION	WIRE	DESTINATION	WIRE
	AR1-J1-A	-20V Output	XQ2-3	WHT-VIO-RED 22	A1-J1-45	WHT-VIO-RED 22
	A	-20V Output	NW7-J1-Z	WHT-VIO-RED 22		
	B	Ampl Out "B"	NW7-J1-9	COAX 1	XK1-11	COAX 2
	B	Ampl Out "B"	E2-N2	COAX 2 Shield		
	C					
	D	+20V Output	VR1-J1-M	WHT-RED-ORN 22	NW7-J1-X	WT-RED-ORN 22
	E	± Grd "B" (DC Ampl)	E2-D1	BLK 16		
	F	Vib Drive (6.3V AC)	T1-12	SHU 1		
	H	Vib Drive Ret.	T1-13	SHU 1 Shield	AR1-J1-U	BUS
	J	+40V Output	C5 (+)	WHT-RED-RED 22		
	K	Bal Pot "B"	R2-2	YEL		
	L	Bal "B" DC Ampl	P2-17	YEL		
	M	H.Q. Grd "B" (DC Ampl)	E2-B2	BLK-WHT 16		
	N	H.Q. Grd "A" (DC Ampl)	E2-B1	BLK-WHT 16		
	P	Bal "A" (DC Ampl)	P2-18	YEL		
	R	Bal Pot "A"	R3-2	YEL		
	S	Ampl Input "B"	NW7-J1-10	BUS	NW1-2	COAX 3
	S	Ampl Input "B"	E2-R1	COAX 3 Shield		
	T	Key				
	U	Chassis Grd	AR1-J1-H	BUS		
	V	Ampl Input "A"	NW7-J1-21	BUS		
	W					
	X					
	Y	± Grd "A" (DC Ampl)	E2-D2	BLK 16		
	Z	Ampl Out "A"	NW7-J1-19	COAX 4	XK1-16	COAX 5
	AR1-J1-Z	Ampl Out "A"	E2-N3	COAX 5		
	AR2-J1-A	6.3V AC (Vib Drive)	T1-12	SHU 2		
	B	Vib Drive Ret. (± Grd)	T1-13	SHU 2 Shield		
	C	± Grd	AR2-J1-J	BUS		
	D	220V CT	T1-17	WHT 22		
	E	220V CT	T1-19	WHT 22		
	F	Key				
	H	F.B. Resistor	NW6-3	BUS		
	J	± Grd	E2-G2	BLK 16	AR2-J1-C	BUS
	K	Filter	C2 (-)	WHT 22		
	L	Input	NW6-1	BUS		
	M	-20V	VR1-J1-N	WHT-VIO-RED 22		
	N	-110V	NW6-7	BUS		
	P	Zener Input	NW6-2	BUS		
	R					
	S	Zener Check 9.4V	P2-4	YEL		
	T	+40V	VR1-J1-E	WHT-RED-RED 22	P2-3	WHT-RED-RED 22
	U					
	V					
	W	-100V Ref.	NW6-4	BUS		
	X					
	Y	Bal.	P2-1	BLK		
	AR2-J1-Z	H.Q. Grd	E2-C1	BLK-WHT 16		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1887	B 026 158 OW

SHEET 4 OF SHEETS

A1-J1 COMPARATOR and DIODE GATE 26.096-1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A1-J1-1	Sum Junction	NW2-J1-E	COAX 6		
	2	8000 In	V	RED		
	3	4000	U	ORN		
	4	2000	T	YEL		
	5	1000	S	GRN		
	6	800	R	BLU		
	7	400	P	VIO		
	8	200	N	GY		
	9	100	M	WHT		
	10	80	D	BLK		
	11	40	C	BRN		
	12	20	B	RED		
	13	10	A	WHT 20		
	14	8	Z	BLK 20		
	15	4	Y	BRN 20		
	16	2	X	RED 20		
	17	1 In	NW2-J1-W	ORN 20		
	18	8000 Gate	A2-J1-X	GY		
	19	4000	A2-J1-U	WHT		
	20	2000	A2-J1-S	BLK		
	21	1000	A2-J1-J	BRN		
	22	800	A3-J1-X	RED		
	23	400	A3-J1-U	ORN		
	24	200	A3-J1-S	YEL		
	25	100	A3-J1-J	GRN		
	26	80	A4-J1-X	BLU		
	27	40	A4-J1-U	VIO		
	28	20	A4-J1-S	GY		
	29	10	A5-J1-J	WHT		
	30	8	A5-J1-X	BLK		
	31	4	A4-J1-J	BRN		
	32	2	A5-J1-S	RED		
	33	1 Gate	A5-J1-J	ORN		
	34	Zero Set	R1-2	GRN		
	35	H.Q. Grd	E2-R2	BLK-WHT 20		
	36					
	37					
	38					
	39	± Grd	E2-R3	BLK 20		
	40					
	41					
	42					
	43					
	44					
	45	-20V	AR1-J1-A	WHT-VIO-RED 22		
	46					
	47	Comparator (-) Out	A6-J1-R	YEL		
	48					
	49	Comparator (+) Out	A6-J1-N	YEL		
	A1-J1-50					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV. NO	
PROJECT 1887	B 026 158 0W

SHEET 5 OF SHEETS

A2-J1 BINARY CODED DECADE COUNTER 44.139-5 (1000's). A3-J1 BINARY CODED DECADE COUNTER 44.139-1 (100's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A2-J1-A	Carry In	A2-J1-N	BUS		
	B	+12V	A3-J1-B	BUS	NW7-J1-B	WHT-RED-ORN 22
	C	Count	A3-J1-C	BUS		
	D	Shift	A3-J1-D	BUS		
	E					
	F	Carry Out	A3-J1-A	YEL	A3-J1-R	YEL
	H	1'	A10-J1-B	ORN		
	J	1	A10-J1-C	BRN	A1-J1-21	BRN
	K	2'	A10-J1-D	RED		
	L	-12V	A3-J1-L	BUS	NW7-J1-A	WHT-VIO-ORN 22
	M	Pull Over	A3-J1-M	BUS	NW7-J1-4	BUS
	N	Zero Set	A3-J1-N	BUS	A2-J1-A	BUS
	P	± Grd	A3-J1-P	BUS	NW7-J1-Y	BLK 16
	R					
	S	2	A10-J1-E	BLK	A1-J1-20	BLK
	T	4'	A10-J1-K	GRN		
	U	4	A10-J1-F	WHT	A1-J1-19	WHT
	V	8'	A10-J1-H	YEL		
	W	Key				
	X	8	A10-J1-J	GY	A1-J1-18	GY
	Y	+2V	A3-J1-Y	BUS	NW7-J1-C	WHT-RED-BLU 22
	A2-J1-Z					
	A3-J1-A	Carry In	A2-J1-F	YEL		
	B	+12V	A2-J1-B	BUS	A4-J1-B	BUS
	C	Count	A2-J1-C	BUS	A4-J1-C	BUS
	D	Shift	A2-J1-D	BUS	A4-J1-D	BUS
	E					
	F	Carry Out	A4-J1-A	YEL		
	H	1'	A9-J1-B	BRN		
	J	1	A9-J1-C	GRN	A1-J1-25	GRN
	K	2'	A9-J1-D	BLU		
	L	-12V	A2-J1-L	BUS	A4-J1-L	BUS
	M	Pull Over	A2-J1-M	BUS	A4-J1-M	BUS
	N	Zero Set	A2-J1-N	BUS	A4-J1-N	BUS
	P	± Grd	A2-J1-P	BUS	A4-J1-P	BUS
	R	Nine Set	A4-J1-R	BUS	A2-J1-F	YEL
	S	2	A9-J1-E	YEL	A1-J1-24	YEL
	T	4'	A9-J1-K	GY		
	U	4	A9-J1-F	ORN	A1-J1-23	ORN
	V	8'	A9-J1-H	VIO		
	W	Key				
	X	8	A9-J1-J	RED	A1-J1-22	RED
	Y	+2V	A2-J1-Y	BUS	A4-J1-Y	BUS
	A3-J1-Z					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W

SHEET 6 OF SHEETS

A4-J1 BINARY CODED DECADE COUNTER 44.139-1 (10's)					A5-J1 BINARY CODED DECADE COUNTER 44.139-1 (1's)	
HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A4-J1-A	Carry In	A3-J1-F	YEL	A11-J1-J	YEL
	B	+12V	A3-J1-B	BUS	A5-J1-B	BUS
	C	Count	A3-J1-C	BUS	A5-J1-C	BUS
	D	Shift	A3-J1-D	BUS	A5-J1-D	BUS
	E					
	F	Carry Out	A5-J1-A	YEL		
	H	1'	A8-J1-B	BRN		
	J	1	A8-J1-C	WHT	A1-J1-29	WHT
	K	2'	A8-J1-D	RED		
	L	-12V	A3-J1-L	BUS	A5-J1-L	BUS
	M	Pull Over	A3-J1-M	BUS	A5-J1-M	BUS
	N	Zero Set	A3-J1-N	BUS	A5-J1-N	BUS
	P	± Grd	A3-J1-P	BUS	A5-J1-P	BUS
	R	Nine Set	A3-J1-R	BUS	A5-J1-R	BUS
	S	2	A8-J1-E	GY	A1-J1-28	GY
	T	4'	A8-J1-K	GRN		
	U	4	A8-J1-F	VIO	A1-J1-27	VIO
	V	8'	A8-J1-H	ORN		
	W	Key				
	X	8	A8-J1-J	BLU	A1-J1-26	BLU
	Y	+2V	A3-J1-Y	BUS	A5-J1-Y	BUS
	A4-J1-Z					
	A5-J1-A	Carry In	A4-J1-F	YEL		
	B	+12V	A4-J1-B	BUS	A6-J1-B	BUS
	C	Count	A4-J1-C	BUS	A6-J1-S	YEL
	D	Shift	A4-J1-D	BUS	A6-J1-P	YEL
	E					
	F	Carry Out	A6-J1-A	YEL		
	H	1'	A7-J1-B	VIO		
	J	1	A7-J1-C	ORN	A1-J1-33	ORN
	K	2'	A7-J1-D	BLU		
	L	-12V	A4-J1-L	BUS	A6-J1-L	BUS
	M	Pull Over	A4-J1-M	BUS	A6-J1-H	YEL
	N	Zero Set	A4-J1-N	BUS	A6-J1-J	YEL
	P	± Grd	A4-J1-P	BUS		
	R	Nine Set	A4-J1-R	BUS		
	S	2	A7-J1-E	RED	A1-J1-32	RED
	T	4'	A7-J1-K	YEL		
	U	4	A7-J1-F	BRN	A1-J1-31	BRN
	V	8'	A7-J1-H	GRN		
	W	Key				
	X	8	A7-J1-J	BLK	A1-J1-30	BLK
	Y	+2V	A4-J1-Y	BUS	P2-10	WHT-RED-BLU 22
	A5-J1-Z					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO	
PROJECT 1867	B 026 158 0W

SHEET 7 OF SHEETS

A6-J1 PROGRAMMER 44.170-3

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A6-J1-A	Carry In	A5-J1-F	YEL	P2-15	YEL
	B	+12V	A5-J1-B	SD-BUS	P2-11	WHT-RED-ORN 22
	C	Key				
	D	Hold	S5-5	YEL		
	E	Ind Clear	NW7-J1-7	YEL	P2-7	YEL
	F	Relay Coil	XK1-4	BLU		
	H	Pull Over	A5-J1-M	YEL	A11-J1-L	YEL
	J	Carry Out	A5-J1-N	YEL	A11-J1-K	YEL
	K	-1 Digit	NW2-J1-F	YEL		
	L	-12V	A5-J1-L	SD-BUS	VR1-J1-P	WHT-VIO-ORN 22
	M	Relay Arm	XK1-9	YEL		
	N	Comparator (+)	A1-J1-49	YEL		
	P	Shift	A5-J1-D	YEL		
	R	Comparator (-)	A1-J1-47	YEL		
	S	Count	A5-J1-C	YEL		
	T					
	U	Cycle Command	S5-3	YEL		
	V	(+) Relay	XK1-10	YEL		
	W	(+) Ind.	NW7-J1-1	YEL		
	X	(-) Ind.	NW7-J1-2	YEL		
	Y	(-) Relay	XK1-8	YEL		
	A6-J1-Z	± Grd	E1-A5	BLK 16		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO.
SIZE
REV NO
PROJECT 1887 B 026 158 0W
SHEET 8 OF SHEETS

A7-J1 READOUT STORAGE DECADE 51.010-1 (1's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A7-J1-A	-8V	A8-J1-A	BUS	P1-50	WHT-VIO-BLU 20
	B	1' Input(Binary Coded)	A5-J1-H	VIO		
	C	1	A5-J1-J	ORN		
	D	2'	A5-J1-K	BLU		
	E	2	A5-J1-S	RED		
	F	4	A5-J1-U	BRN		
	H	8'	A5-J1-V	GRN		
	J	8	A5-J1-X	BLK		
	K	4' Input(Binary Coded)	A5-J1-T	YEL		
	L	Shift	A8-J1-L	BUS		
	M	± Grd	A8-J1-M	BUS		
	N	Key				
	P	0 Output(Digital)	DS4-10	BLK	P1-1	BLK
	R	1 Output	DS4-1	BRN	P1-2	BRN
	S	2 Output	DS4-2	RED	P1-3	RED
	T	3 Output	DS4-3	ORN	P1-4	ORN
	U	4 Output	DS4-4	YEL	P1-5	YEL
	V	5 Output	DS4-5	GRN	P1-6	GRN
	W	6 Output	DS4-6	BLU	P1-7	BLU
	X	7 Output	DS4-7	VIO	P1-8	VIO
	Y	8 Output	DS4-8	GY	P1-9	GY
	A7-J1-Z	9 Output (Digital)	DS4-9	WHT	P1-10	WHT
	A7-J1-1					
	2	1'(Binary Coded Outputs)	P1-51	WHT-RED		
	3					
	4	2'	P1-52	WHT-BRN		
	5					
	6					
	7	8'	P1-54	WHT-VIO		
	8					
	9	4'(Binary Coded Outputs)	P1-53	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	15					
	17					
	18					
	19					
	20					
	21					
	A7-J1-22					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO	
SIZE	
REV NO	
PROJECT 1587	B 026 156 0W

SHEET 9 OF SHEETS

A8-J1 READOUT STORAGE DECADE 51.010-1 (10's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A8-J1-A	-8V	A7-J1-A	BUS	A9-J1-A	BUS
	B	1' Input(Binary Coded)	A4-J1-H	BRN		
	C	1	A4-J1-J	WHT		
	D	2'	A4-J1-K	RED		
	E	2	A4-J1-S	GY		
	F	4	A4-J1-U	VIO		
	H	8'	A4-J1-V	ORN		
	J	8	A4-J1-X	BLU		
	K	4' Input (Binary Coded)	A4-J1-T	GRN		
	L	Shift	A7-J1-L	BUS	A9-J1-L	BUS
	M	± Grd	T1-15	BLK 16	A7-J1-M	BUS
	N	Key				
	P	0 Output(Digital)	DS3-10	BLK	P1-11	BLK
	R	1 Output	DS3-1	BRN	P1-12	BRN
	S	2 Output	DS3-2	RED	P1-13	RED
	T	3 Output	DS3-3	ORN	P1-14	ORN
	U	4 Output	DS3-4	YEL	P1-15	YEL
	V	5 Output	DS3-5	GRN	P1-16	GRN
	W	6 Output	DS3-6	BLU	P1-17	BLU
	X	7 Output	DS3-7	VIO	P1-18	VIO
	Y	8 Output	DS3-8	GY	P1-19	GY
	A8-J1-Z	9 Output (Digital)	DS3-9	WHT	P1-20	WHT
	A8-J1-1					
	2	1'(Binary Coded Outputs)	P1-55	WHT-RED		
	3					
	4	2'	P1-56	WHT-BRN		
	5					
	6					
	7	8'	P1-58	WHT-VIO		
	8					
	9	4'(Binary Coded Outputs)	P1-57	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	A8-J1-22					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO	
PROJECT 1887	B 026 158 0W

SHEET 10 OF SHEETS

A9-J1 READOUT STORAGE DECADE 51.010-1 (100's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A9-J1-A	-8V	A8-J1-A	BUS	A10-J1-A	BUS
	B	1' Input(Binary Coded)	A3-J1-H	BRN		
	C	1	A3-J1-J	GRN		
	D	2'	A3-J1-K	BLU		
	E	2	A3-J1-S	YEL		
	F	4	A3-J1-U	ORN		
	H	8'	A3-J1-V	VIO		
	J	8	A3-J1-X	RED		
	K	4' Inout(Binary Coded)	A3-J1-T	GY		
	L	Shift	A8-J1-L	BUS	A10-J1-L	BUS
	M	± Grd	A10-J1-M	BUS		
	N	Key				
	P	0 Output (Digital)	DS2-10	BLK	P1-21	BLK
	R	1 Output	DS2-1	BRN	P1-22	BRN
	S	2 Output	DS2-2	RED	P1-23	RED
	T	3 Output	DS2-3	ORN	P1-24	ORN
	U	4 Output	DS2-4	YEL	P1-25	YEL
	V	5 Output	DS2-5	GRN	P1-26	GRN
	W	6 Output	DS2-6	BLU	P1-27	BLU
	X	7 Output	DS2-7	VIO	P1-28	VIO
	Y	8 Output	DS2-8	GY	P1-29	GY
	A9-J1-Z	9 Output (Digital)	DS2-9	WHT	P1-30	WHT
	A9-J1-1					
	2	1'(Binary Coded Outputs)	P1-59	WHT-RED		
	3					
	4	2'	P1-60	WHT-BRN		
	5					
	6					
	7	8'	P1-62	WHT-VIO		
	8					
	9	4'(Binary Coded Outputs)	P1-61	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	A9-J1-22					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV NO.	
PROJECT 1887	B 026 158 0W

SHEET 11 OF SHEETS

A10-J1 READOUT STORAGE DECADE 51.080 (1000's)/(10,000's)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A10-J1-A	-8V	A9-J1-A	BUS	R11-2	WHT-VIO-BLU 20
	B	1 Input (Binary Coded)	A2-J1-H	ORN	A11-J1-W	ORN
	C	1	A2-J1-J	BRN		
	D	2'	A2-J1-K	RED	A11-J1-V	RED
	E	2	A2-J1-S	BLK		
	F	4	A2-J1-U	WHT	A11-J1-F	WHT
	H	8'	A2-J1-V	YEL	A11-J1-T	YEL
	J	8	A2-J1-X	GY	A11-J1-H	GY
	K	4' Input (Binary Coded)	A2-J1-T	GRN	A11-J1-U	GRN
	L	Shift	A9-J1-L	BUS	NW7-J1-3	YEL
	M	± Grd	A9-J1-M	BUS	A11-J1-D	BLK 16
	N	Key				
	P	0 Output (Digital)	DS1-10	BLK	P1-31	BLK
	R	1 Output	DS1-1	BRN	P1-32	BRN
	S	2 Output	DS1-2	RED	P1-33	RED
	T	3 Output	DS1-3	ORN	P1-34	ORN
	U	4 Output	DS1-4	YEL	P1-35	YEL
	V	5 Output	DS1-5	GRN	P1-36	GRN
	W	6 Output	DS1-6	BLU	P1-37	BLU
	X	7 Output	DS1-7	VIO	P1-38	VIO
	Y	8 Output	DS1-8	GY	P1-39	GY
	A10-J1-Z	9 Output (Digital)	DS1-9	WHT	P1-40	WHT
	A10-J1-1	1 (10,000's)	P1-67	YEL		
	2	1' (Binary Coded Output)	P1-63	WHT-RED		
	3					
	4	2'	P1-64	WHT-BRN		
	5					
	6					
	7	8'	P1-66	WHT-VIO		
	8					
	9	4' (Binary Coded Output)	P1-65	WHT-GY		
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21	1' (Digital Output)	DS5-7	VIO	P1-42	VIO
	A10-J1-22	0' (Digital Output)	DS5-8	GY	P1-41	GY

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.
SIZE
REV NO
PROJECT 1887 B 026 158 0W
SHEET 12 OF SHEETS

A11-J1 AUTOMATIC RANGE SWITCH 14.11[illegible]

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	A11-J1-A	-12V	VR1-J1-P	WHT-VIO-ORN 22	P1-49	WHT-VIO-ORN 22
	B	+12V	VR1-J1-S	WHT-RED-ORN 22		
	C	+2V	VR1-J1-T	WHT-RED-BLU 22		
	D	± Grd	T1-15	BLK 16	A10-J1-M	BLK 16
	E	Over Range Ind	DS5-9	WHT	P4-10	WHT
	F	4000 Gate (Up Range)	A10-J1-F	WHT		
	H	8000 Gate (Up Range)	A10-J1-J	GY		
	J	100's Mult Out (Up Rge)	A4-J1-A	YEL	A11-J1-X	BUS
	K	Sign Check Inhibit	A6-J1-J	YEL		
	L	Full Over	A6-J1-H	YEL		
	M	Key				
	N	A.R.S. Com (K3)	P4-1	BRN		
	P	K3 Relay Drive	P4-7	BLU	S3-5	BLU
	R	Manual Protects	P4-5	GRN	S3-7	GRN
	S	Relay Drive (K2)	K2-14	BLU		
	T	8000 Gate (Down Range	A10-J1-H	YEL		
	U	4000 Gate	A10-J1-K	GRN		
	V	2000 Gate	A10-J1-D	RED		
	W	1000 Gate	A10-J1-B	ORN		
	X	100's Mult (Down Range	A11-J1-J	BUS		
	Y	Auto	P4-4	YEL	S3-3	YEL
	A11-J1-Z	A.R.S. Com (K2)	P4-2	RED		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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SHEET 13 OF SHEETS

DS1 - DS3 (INDICATOR DISPLAY UNITS)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	DS1-1	1(Digital Output)	A10-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10Digital Output)	A10-J1-P	BLK		
	11	Dec. Ind (1V)	K3-6	WHT-BRN	P1-43	WHT-BRN
	12					
	DS1-COM	Ind Com	DS5-COM	BUS 20	DS2-COM	BUS 20
	DS2-1	1(Digital Output)	A9-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10(Digital Output)	A9-J1-P	BLK		
	11	Dec. Ind (10V)	K3-4	WHT-RED	P1-44	WHT-RED
	12					
	DS2-COM	Ind Com	DS1-COM	BUS 20	DS3-COM	BUS 20
	DS3-1	1(Digital Output)	A8-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	10(Digital Output)	A8-J1-P	BLK		
	11	Dec. Ind (100V)	K3-1	WHT-VIO	P1-45	WHT-VIO
	12					
	DS3-COM	Ind Com	DS2-COM	BUS 20	DS4-COM	BUS 20

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO.
SIZE
REV NO
PROJECT 1887 B 026 158 0W
SHEET 14 OF SHEETS

DS4 - DS5 (INDICATOR DISPLAY UNITS)

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	DS4-1	1(Digital Output)	A7-J1-R	BRN		
	2	2	S	RED		
	3	3	T	ORN		
	4	4	U	YEL		
	5	5	V	GRN		
	6	6	W	BLU		
	7	7	X	VIO		
	8	8	Y	GY		
	9	9	Z	WHT		
	10	0 (Digital Output)	A7-J1-P	BLK		
	11	Dec. Ind (1000V)	K3-3	WHT-GY	P1-46	WHT-GY
	12					
	DS4-COM	Ind Com	DS3-COM	BUS 20		
	DS5-1					
	2					
	3					
	4	(+) Ind	XK1-7	YEL	P1-70	YEL
	5	(-) Ind	XK1-5	GRN	P1-71	GRN
	6					
	7	1' 10,000'S	A10-J1-21	VIO		
	8	0'	A10-J1-22	GY		
	9	Over Range Ind	A11-J1-E	WHT		
	10					
	11					
	12					
	DS5-COM	Ind Common	DS1-COM	BUS 20	C1 (-)	BUS 20

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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PROJECT 1887	B 026 158 0W

SHEET 15 OF SHEETS

P1 PRINTER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	P1-1	0 Digital Output	A7-J1-P	BLK		
	2	1	R	BRN		
	3	2	S	RED		
	4	3	T	ORN		
	5	4	U	YEL		
	6	5	V	GRN		
	7	6	W	BLU		
	8	7	X	VIO		
	9	8	Y	GY		
	10	9	A7-J1-Z	WHT		
	11	0	A8-J1-P	BLK		
	12	1	R	BRN		
	13	2	S	RED		
	14	3	T	ORN		
	15	4	U	YEL		
	16	5	V	GRN		
	17	6	W	BLU		
	18	7	X	VIO		
	19	8	Y	GY		
	20	9	A8-J1-Z	WHT		
	21	0	A9-J1-P	BLK		
	22	1	R	BRN		
	23	2	S	RED		
	24	3	T	ORN		
	25	4	U	YEL		
	26	5	V	GRN		
	27	6	W	BLU		
	28	7	X	VIO		
	29	8	Y	GY		
	30	9	A9-J1-Z	WHT		
	31	0	A10-J1-P	BLK		
	32	1	R	BRN		
	33	2	S	RED		
	34	3	T	ORN		
	35	4	U	YEL		
	36	5	V	GRN		
	37	6	W	BLU		
	38	7	X	VIO		
	39	8	Y	GY		
	P1-40	9 (Digital Output)	A10-J1-Z	WHT		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
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SHEET 16 OF SHEETS

P1 CONT'D PRINTER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	P1-41	0' Digital Out (1,000's)	A10-J1-22	GY		
	42	1' Digital Out (1,000's)	A10-J1-21	VIO		
	43	Dec. Ind (1V)	DS1-11	WHT-BRN		
	44	Dec. Ind (10V)	DS2-11	WHT-RED		
	45	Dec. Ind (100V)	DS3-11	WHT-VIO		
	46	Dec. Ind (1000V)	DS4-11	WHT-GY		
	47	± Grd	E1-A3	BLK 16	P2-16	BLK 20
	48	Carry In	P2-15	YEL		
	49	-12V	A11-J1-A	WHT-VIO-ORN 22	P2-14	WHT-VIO-ORN 22
	50	-8V	A7-J1-A	WHT-VIO-BLU 20	P2-13	WHT-VIO-BLU 20
	51	1'(1's) (BinaryCodeOutp)	A7-J1-2	WHT-RED		
	52	2'(1's)	A7-J1-4	WHT-BRN		
	53	4'(1's)	A7-J1-9	WHT-GY		
	54	8'(1's)	A7-J1-7	WHT-VIO		
	55	1'(10's)	A8-J1-2	WHT-RED		
	56	2'(10's)	A8-J1-4	WHT-BRN		
	57	4'(10's)	A8-J1-9	WHT-GY		
	58	8'(10's)	A8-J1-7	WHT-VIO		
	59	1'(100's)	A9-J1-2	WHT-RED		
	60	2'(100's)	A9-J1-4	WHT-BRN		
	61	4'(100's)	A9-J1-9	WHT-GY		
	62	8'(100's)	A9-J1-7	WHT-VIO		
	63	1'(1000's)	A10-J1-2	WHT-RED		
	64	2'(1000's)	A10-J1-4	WHT-BRN		
	65	4'(1000's)	A10-J1-9	WHT-GY		
	66	8'(1000's)	A10-J1-7	WHT-VIO		
	67	1'(10,000's) (BinCodeOtg	A10-J1-1	YEL		
	68	Hold	NW7-J1-8	YEL		
	69	Ind Clear	P2-7	YEL		
	70	(+) Ind	DS5-4	YEL		
	71	(-) Ind	DS5-5	GRN		
	72	Over Range	P4-10	WHT		
	73					
	74					
	75					
	76					
	77					
	P1-78					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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SHEET 17 OF SHEETS

P2 TEST POINTS			P3 AC INPUT (LINE)			
			COLUMN 1		COLUMN 2	
HARN/CABLE	TERMINAL	FUNCTION	DESTINATION	WIRE	DESTINATION	WIRE
	P2-1	Bal Ref Ampl	AR2-J1-Y	BLK		
	2	-100V Ref	S2a-C	WHT-VIO 22		
	3	+40V	AR2-J1-T	WHT-RED-RED 22		
	4	9.4V Zen Chk	AR2-J1-S	YEL		
	5	-20V	R2-1	WHT-VIO-RED 22		
	6	-110V	NQ6-7	WHT 22		
	7	Ind Clear	A6-J1-E	YEL	P1-69	YEL
	8	Ampl Out "A"	NW7-J1-19	COAX 12		
	9	Ampl Out "B"	NW7-J1-9	COAX 13		
	10	+2V	A5-J1-Y	WHT-RED-BLU 22		
	11	+12V	P4-9	WHT-RED-ORN 22	A6-J1-B	WHT-RED-ORN 22
	12	+20V	VR1-J1-M	WHT-RED-ORN 22		
	13	-5V	P1-50	WHT-VIO-BLU 20		
	14	-12V	P1-49	WHT-VIO-ORN 22		
	15	Carry In	P1-48	YEL	A6-J1-A	YEL
	16	+ Grd	P1-47	BLK 20		
	17	Bal "B" (DC Ampl)	AR1-J1-L	YEL		
	18	Bal "A" (DC Ampl)	AR1-J1-P	YEL		
	19					
	20					
	21					
	22					
	23					
	24					
	P2-25					
	P3-0	115V AC (Hot)	XF1-1	(0) BLK		
	P3-5	Earth Grd	E4 Lug	(5) GRN		
	P3-9	115V AC (Com)	E4	(9) WHT		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

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P4 PROGRAMMING

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1		COLUMN 2	
			DESTINATION	WIRE	DESTINATION	WIRE
	P4-1	A.R.S. Com (K3)	A11-J1-N	BRN	NW7-J1-6	BRN
	2	A.R.S. Com (K2)	A11-J1-Z	RED	NW7-J1-5	RED
	3	Remote	S3-2	ORN		
	4	Auto	A11-J1-Y	YEL		
	5	1V Range	A11-J1-R	GRN		
	6	10V Range	S3-6	VIO		
	7	100V Range	A11-J1-P	BLU		
	8	Ext Cycle Com	S5-1	GY		
	9	+12V	P2-11	WHT-RED-ORN 22	VR1-J1-S	WHT-RED-ORN 22
	10	Over Range	A11-J1-E	WHT	P1-72	WHT
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	P4-45					

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
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PROJECT 1887	B 026 158 0W

SHEET 19 OF SHEETS

NW7-J1 NETWORK CARD (MISC.) 12.687

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	NW7-J1-1	(+) Ind	A6- J1-W	YEL		
	2	(-) Ind	A6-J1-X	YEL		
	3	Shift (RSP)	A10-J1-L	YEL		
	4	Pull Over	A2-J1-M	BUS		
	5	A.R.S. Com(K2)	P4- 2	RED		
	6	A.R.S. Com(K3)	P4-1	BRN		
	7	Ind Clear	A6-J1-E	YEL		
	8	Hold	P1-68	YEL		
	9	Ampl Out "B"	AR1-J1-B	COAX 1	P2-9	COAX 13
		Coax 1 Shield	E2	BLK 20		
		Coax 13 Shield	E2-P3	BLK 20		
	10	Ampl Inp "B"	AR1-J1-S	BUS		
	11					
	12	Input 1V	S8-6	COAX 14		
		Coax 14 Shield	E2-N2	BLK 20		
	13	Key				
	14	Input 10V	S8-3	COAX 15		
		Coax 15 Shield	E2-N3	BLK 20		
	15	Unloading 10V	S8-2	COAX 16		
		Coax 16 Shield	E2-G3	BLK 20		
	16	Unloading (1) 1V	NW1-11	COAX 17		
		Coax 17 Shield	E2-F3	BLK 20		
	17	Summing Junction	NW2-J1-E	COAX 18		
	18	Full Scale Adj	XK1-12	COAX 19		
		Coax 19 Shield	E2-E3	BLK 20		
	19	Ampl Out "A"	AR1-J1-Z	COAX 4	P2-8	COAX 12
		Coax 4 Shield	E2-C3	BLK 20		
	20	Input (Sum. Resistor)	NW2-J1-H	COAX 20		
		Coax 20 Shield	E2- E3	BLK 20		
	21	Ampl Inp "A"	AR1-J1-V	BUS		
	22					
	A	-12V	A2-J1-L	WHT-VIO-ORN 22		
	B	+12	A2-J1-B	WHT-RED-ORN 22		
	C	+2V	A2-J1-Y	WHT-RED-BLU 22	R8-1	WHT-RED-BLU 22
	D					
	E					
	F					
	H					
	J					
	K					
	L					
	M					
	N					
	P					
	R					
	S					
	T					
	U					
	V					
	W					
	X	+20V	AR-J1-D	WHT-RED-ORN 22		
	Y	± Grd	C4(+)	BLK 16	A2-J1-P	BLK 16
	NW7-J1-Z	-20V	AR1-J1-A	WHT-VIO-RED 22		

ELECTRONIC ASSOCIATES, INC.
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SHT. NO	
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PROJECT 1827	B 026 158 0W

SHEET 20 OF SHEETS

NW1 INPUT RESISTOR NETWORK, 12. 725

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	NW1-1	1000V/100V Input	K2-12	BUS 20		
	2	Ampl Input "B"	AR1-J1-S	COAX 3		
	3	10V/1V Input	K2-10	BUS 20		
	4	Output "B"	K3-11	BUS 20		
	5	1000V/10V F.B.	K2-8	BUS 20		
	6	1V Unl'd Input	K3-9	BUS 20		
	7	1V Unl'd Output	NW1-10	BUS 20	S8-5	COAX 31
	8	10V Unl'd Input	K3-7	BUS 20		
	9	10V Unl'd Output	S8-2	COAX 30		
	10	1V Unl'd Input	NW1-7	BUS 20		
	NW1-11	1V Unl'd Output	NW7-J1-16	COAX 17		

NW6 REF AMPL NETWORK 12.722

	NW6-1	Input	AR2-J1-L	BUS		
	2	Zener Input	AR2-J1-P	BUS		
	3	F.B. Resistor	AR2-J1-H	BUS		
	4	-100V Ref	AR2-J1-W	BUS	S2a-C	WHT-VIO 22
	5	Zero Set	R1-1	WHT-VIO 22		
	6	-100V Ref (Ext)	S2b-C	WHT-VIO 22		
	7	Filter(-110)	AR2-J1-N	BUS	P2-6	WHT 22
	NW6-8	Filter Grd (-110)	T1-18	BLK 16		

NW8 RECTIFIER NETWORK 12.675

	NW8-1	± Grd (-20V)	E1-A4	BLK 16		
	2	+40V (Reg)	C5 (+)	WHT-RED-RED 22		
	3	+20V (Reg)	XQ3-3	WHT-RED-ORN		
	4	36V AC (+40)	T1-9	WHT-RED-RED		
	5	39V AC (+20)	T1-8	WHT-RED-ORN		
	6	39V AC (+20)	T1-6	WHT-RED-ORN		
	7	36V AC (+40)	T1-11	WHT-RED-RED		
	8	+20V (Unreg)	R5-1	WHT-RED-ORN		
	9	+40V (Unreg)	E9	WHT-RED-RED		
	10	-20V (Unreg)	R6-1	WHT-VIO-RED 22		
	11	-8V	R11-1	WHT-VIO-BLU 20		
	12	39V AC (-20)	T1-3	WHT-VIO-RED 22		
	13	15V CT(-8)	T1-16	WHT-VIO-BLU 20		
	14	15V CT(-8)	T1-14	WHT-VIO-BLU 20		
	15	39V AC (-20)	T1-5	WHT-VIO-RED 22		
	NW8-16	-8V	R11-3	WHT-VIO-BLU 20		

NW2-J1 SUMMING RESISTOR NETWORK 26.116

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1		COLUMN 2	
			DESTINATION	WIRE	DESTINATION	WIRE
	NW2-J1-A	10	A1-J1-13	WHT 20		
	B	20	A1-J1-12	RED		
	C	40	A1-J1-11	BRN		
	D	80	A1-J1-10	BLK		
	E	Summing Junc.	A1-J1-1	COAX 6	NW7-J1-17	COAX 18
	F	-1 Digit	A6-J1-K	YEL		
	H	Input	NW7-J1-20	COAX 20		
	J	Key				
	K	-100V Ref	S2a-NC	WHT-VIO 22		
	L	± Grd	E2- G1	BLK 16		
	M	100	A1-J1-9	WHT		
	N	200	8	GY		
	P	400	7	VIO		
	R	800	6	BLU		
	S	1000	5	GRN		
	T	2000	4	YEL		
	U	4000	3	ORN		
	V	8000	2	RED		
	W	1	17	ORN 20		
	X	2	16	RED 20		
	Y	4	15	BRN 20		
	NW2-J1-Z	8	A1-J1-14	BLK 20		

82 INTERNAL/EXTERNAL REFERENCE

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
		S2 INTERNAL /EXTERNAL REFERENCE				
	S2a-C	-100V Ref	NW6-4	WHT-VIO 22	P2-2	WHT-VIO 22
	NC	-100V Ref	NW2-J1-K	WHT-VIO 22	S2b-C	BUS
	S2a-NO	HQ Grd	R13	See Sht 2		
	S2b-C, NC	-100V Ref	S2a-NC	BUS	NW6-6	WHT-VIO 22
	S2b-NO	Ext Ref	J2-A	WHT-VIO 22		
		S3 RANGE				
	S3-1	± Grd	C4 (+)	BLK 16		
	2	Remote	P4-3	ORN		
	3	Auto	A11-J1-Y	YEL		
	4					
	5	100V	K3-14	BLU	A11-J1-P	BLU
	6	10V	P4-6	VIO		
	7	1V	A11-J1-R	GRN		
	8					
	S3-9					
		S8 INPUT Z				
	S8-1					
	2	Unl'd 10V	NW1-9	COAX 30	NW7-J1-15	COAX 16
	3	Input 10V	NW7-J1-14	COAX 15		
	4					
	5	Unl'd 1V	NW1-7	COAX 31		
	S8-6	Input 1V	NW7-J1-12	COAX 14		

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SHEET 23 OF SHEETS

S4 POWER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	S4-1	115V AC (On)	S4-6	BUS	XF1-2	BLK (T #2)
	2	115V AC (Off)	S4-7	BUS	E3	RED (T #2)
	3	Input	K 2-11	COAX 24		
		Coax 24 Shield	R1—3	BLK 20		
	4	Input	K.2-5	COAX 25		
		Coax 25 Shield	R1-3	BLK 20		
	5	Input	J1-1	COAX 26	J3-1	COAX 27
		Coax 26 Shield	R1-3	BLK 20		
		Coax 27 Shield	R1-3	BLK 20		
	6	115V AC (On)	S4-1	BUS		
	S4-7	115V AC (Off)	S4-2	BUS		
		S5 FUNCTION				
	S5-1	Ext (Cycle Com.)	P4-8	GY		
	2	Man Push	S7-1	BUS		
	3	Cycle Com.	A6-J1-U	YEL		
	4	Int (+12V)	VR1-J1-S	WHT-RED-ORN 22	S7-2	BUS
	5	Hold	A6-J1-D	YEL		
	6	± Grd	C4 (+)	BLK 16		
	7					
	S5-8					
		S7 - TRIGGER				
	S7-1	Manual Push	S5-2	BUS 20		
	S7-2	+12V	S5-4	BUS 20		

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SHEET 24 OF SHEETS

E1, ± GROUND E2, H.Q. GRD

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	E1-A1	(-20V)	C4 (+)	BLK 16		
	2	(Power Supply)	VR1-J1-Z			
	3	(Output)	P1-47			
	4	(Rect. Network)	NW8-1			
	5	(Prog)	A6-J1-Z			
	6	(Inter. Block)	E2-F2			
	7	(C.T. -220)	T1-18			
	8	(Transformer)	T1-20			
	9	(+20V)	XQ4-3			
	-A10	(6.3V AC Ret)	T1-13			
	B1					
	2	(C.T. -8V)	T1-15			
	E1-B3	(± Ind)	E8	BLK 16		
		E2 H.Q. GROUND				
	E2-A1	AR1-J1-Z	Coax 5 Shield	BLK 20		
	A2		C6-2	BLK 20	E2-B1	BLK 16
	A3					
	B1	"A" (DC Ampl)	AR1-J1-N	BLK-WHT 16	E2-A2	BLK 16
	B2	"B" (DC Ampl)	AR1-J1-M	BLK-WHT 16	E2-C1	BLK 16
	B3	NW7-J1-20	Coax 20 Shield	BLK 20		
	C1	Ref Ampl	AR2-J1-Z	BLK-WHT-16	E2-E2	BLK 16
	C2	± Grd (Junct)	E5	BLK 16	E2-D1	BLK 16
	C3	NW7-J1-19	Coax 4 Shield	BLK 20		
	D1	"B" (DC Ampl)	AR1-J1-E	BLK 16	E2-C2	BLK 16
	D2	"A" (DC Ampl)	AR1-J1-Y	BLK 16	E2-E1	BLK 16
	D3	NW7-J1-19	Coax 12 Shield	BLK 20		
	E1	Zero Set	R1-3	BLK 16	E2-D2	BLK 16
	E2	Input "B" and FB	E6	BLK 16	E2-F1	BLK 16
	E3	NW7-J1-18	Coax 19 Shield	BLK 20		
	F1	Bal POT "A"	R3-3	BLK 16	E2-E2	BLK 16
	F2	Inter. Block	E1-A6	BLK 16	E2-C1	BLK 16
	F3	NW7-J1-16	Coax 17 Shield	BLK 20		
	G1	Sum. Res.	NW2-J1-L	BLK 16	E2-F2	BLK 16
	G2	Ref. Amp	AR2-J1-J	BLK 16	E2-H1	BLK 16
	G3	NW7-J1-15	Coax 16 Shield	BLK 20		
	H1	AR1-J1-S	Coax 3 Shield	BLK 20	E2-G2	BLK 16
	H2	Jumper	E2-R1	BLK 16		
	H3					
	J1					
	J2					
	J3					
	K1					
	K2					
	K3					
	L1					
	L2					
	L3					
	M1					
	M2					
	M3					
	N1				E2-P2	BLK 16
	N2	NW7-J1-12	Coax 14 Shield	BLK 20		
	N3	NW7-J1-14	Coax 15 Shield	BLK 20	E2-R2	BLK 16
	P1	AR1-J1-B	Coax 2 Shield	BLK 20		
	P2	NW7-J1-9	Coax 15 Shield	BLK 20	E2-N1	BLK 16
	P3	NW7-J1-9	Coax 13 Shield	BLK 20		
	R1				E2-H2	BLK 16
	R2	H.Q.Grd (Comp)	A1-J1-35	BLK-WHT 20	E2-N3	BLK 16
	E2-R3	± Grd (Comp)	A1-J1-39	BLK 20		

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PROJECT 1887 B 026 158 0W
SHEET 25 OF SHEETS

E2 H.Q. GROUND (Cont'd) E3,4 - Etc.

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	E2-S1					
	S2					
	S3					
	T1					
	T2					
	T3					
	U1					
	U2					
	U3					
	V1					
	V2					
	V3	6.3V AC (TH1)(-)(Ret)	T1-13	SHU 3 Shield	TH1 (-)	WHT-BRN 20T
	W1	6.3V AC (TH1)(+)(Hot)	T1-12	SHU 3	TH1 (+)	BRN 20T
	W2					
	E2-W3					
	E3	115V AC (Hot)	S4-2	RED (T #2)	T1-2B	RED (T #1)
	E4	115V AC (Com)	T1-1	BLK (T #1)	P3-9	
	E4 Lug	115V AC Earth Grd	T #1	Shield	T #2	Shield
	E4 Lug	115V AC Earth Grd	P3-5			
	E5	± Grd	E2-C2	BLK 16		
	E5	± Grd	J2-A	BLK 20		
	E5					
	E5 Lug	± Grd (Chassis)	C6-1	BLK 20		
	E6	± Grd (Input)	E2-E2	BLK 16	K3-11	COAX 29 Shield
	E7	-8V Grd	C1 (+)	BLK 16		
	E8	± Grd (± Ind)	E1-B3	BLK 16		
	E9	+40V (Output)	NW8-9	WHT-RED-RED 22		

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SHEET 26 OF SHEETS

T1 - TRANSFORMER, POWER

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	T1-1	115V AC Com	E4	BLK (T#1)	B1-2	BLK (T#3)
	-1	115V AC Com	T1-2A	BUS #20		
	2A	115V AC	T1-1	BUS #20		
	2B	115V AC	E3	RED (T#1)	B1-1	RED (T#3)
	2B	115V AC	T1-2C	BUS #20		
	2C	115V	T1-2B	BUS #20		
	3	39V AC (-20)	NW8-12	WHT-VIO-RED 22		
	4					
	5	39V AC (-20)	NW8-15	WHT-VIO-RED 22		
	6	39V AC (+20)	NW8-6	WHT-RED-ORN 22		
	7					
	8	39V AC (+20)	NW8-5	WHT-RED-ORN 22		
	9	36V AC (+40)	NW8-4	WHT-RED-RED 22		
	10					
	11	36V AC (+40)	NW8-7	WHT-RED-RED 22		
	12	6.3V AC (Vib Drive)	AR1-J1-F	SHU 1	AR2-J1-A	SHU 2
	12	6.3V AC (Vib Drive)	E2-W1	SHU 3		
	13	Vib Drive Ret	AR1-J1-H	SHU 1 Shield	AR2-J1-B	SHU 2 Shield
	13	Vib Drive Ret	E2-V3	SHU 3 Shield	E1-A10	BLK 16
	14	15V AC (-8)	NW8-14	WHT-VIO-BLU 20		
	15	C.T. Grd (-8)	C1 (+)	BLK 16	A11-J1-D	BLK 16
	15	C.T. Grd (-8)	E1-B2	BLK 16	A8-J1-M	BLK 16
	16	15V AC (-8)	NW8-13	WHT-VIO-BLU 20		
	17	220V AC (-110)	AR2-J1-D	WHT 22		
	18	C. T. Grd (-110)	C2 (+)	BLK 16	NW6-8	BLK 16
	18	C. T. Grd (-110)	E1-A7	BLK 16		
	19	220V AC (-110)	AR2-J1-E	WHT		
	T1-20	Transformer Grd	E1-A8	BLK 16		
	J1-1	Input (F.P.)	S4-5	COAX 26		
	J1-2	Conn. Grd	COAX 26 Shield	BLK 20		
	J2-C	Ext. Ref	S2b-NO	WHT-VIO 20		
	J2-A	Conn. Grd	E5	BLK 20	R13	See Sht 2
	J3-1	Input (R.P.)	S4-5	COAX 27		
	J3-2	Conn. Grd	Coax 27 Shield	BLK 20		

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SHEET 27 OF SHEETS

XK1, SIGN SWITCHING

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	XK1-1	Relay Coil (-12V)	XQ1-3	WHT-VIO-ORN 22		
	2					
	3					
	4	Relay Coil	A6-J1-F	BLU		
	5	NC (-Ind)	DS5-5	GRN		
	6					
	7	NO (+ Ind)	DS5-4	YEL		
	8	NC (-Relay)	A6-J1-Y	YEL		
	9	Arm, Relay	A6-J1-M	YEL		
	10	NO (+Relay)	A6-J1-V	YEL		
	11	Ampl Out "B"	XK1-14	BUS	AR1-J1-B	COAX 2
	12	Full Scale Adj	XK1-15	BUS	NW7-J1-18	COAX 19
	13	Ampl Out "A"	XK1-16	BUS		
	14	Ampl Out "B"	XK1-11	BUS	K3-11	COAX 29
	15	Arm (F.S. Adj)	XK1-12	BUS		
	XK1-16	Ampl Out "A"	XK1-13	BUS	AR1-J1-Z	COAX 5
		K2 AUTO RANGE SWITCHING				
	K2-1	NO (Arm)	K3-5	BUS 20		
	2					
	3	NC (Arm)	K3-2	BUS 20		
	4	NO (Arm)	K3-8	BUS 20		
	5	Arm (Input)	S4-4	COAX 25		
	6					
	7	NO	K3-10	BUS 20		
	8	Arm (Input "B")	NW1-5	BUS 20		
	9	NC	K3-12	BUS 20		
	10	10V/1V Input	NW1-3	BUS 20		
	11	Input	S4-3	COAX 24		
	12	NC (1000V/100V Inp)	NW1-1	BUS 20		
	13	Relay Coil (-24V)	K3-13	BUS 20	C4 (-)	WHT-VIO-RED 22
	K2-14	Relay Drive	A11-J1-S	BLU		
		K3 AUTO RANGE SWITCHING				
	K3-1	Dec Ind (100V)	DS3-11	WHT-VIO		
	2	Arm (NC)	K2-3	BUS 20		
	3	Dec.Ind (1000V)	DS4-11	WHT-GY		
	4	Dec. Ind (10V)	DS2-11	WHT-RED		
	5	Arm (NO)	K2-1	BUS 20		
	6	Dec. Ind (1V)	DS1-11	WHT-BRN		
	7	10V Unl'd Input	NW1-8	BUS 20		
	8	Arm (NO)	K2-4	BUS 20		
	9	1V Unl'd Input	NW1-6	BUS 20		
	10	NO	K2-7	BUS 20		
	11	Output "B"	NW1-4	BUS 20	XK1-14	COAX 29
	11	Output "B"	E6	COAX 29 Shield		
	12	NC	K2-9	BUS 20		
	13	Relay Coil (-24V)	K2-13	BUS 20		
	K3-14	Relay Drive	S3-5	BLU		

R1, 2, 3, 5, 6, 8 and R11

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	R1-1	Zero Set	NW6-5	WHT-VIO 22		
	2	Zero Set	A1-J1-34	GRN		
	R1-3	± Grd	E2-E1	BLK 20		
		COAX 24 Shield	R1-3			
		25				
		26				
		COAX 27 Shield	R1-3	BLK 20		
	R2-1	-20V Output	R3-1	BUS	P2-5	WHT-VIO-RED 22
	2	Bal Pot "B"	AR1-J1-K	YEL		
	R2-3	± Grd	R3-3	BUS		
	R3-1	-20V Output	VR1-J1-N	WHT-VIO-RED 22	R2-1	BUS
	2	Bal Pot "A"	AR1-J1-R	YEL		
	R3-3	± Grd	R2-3	BUS	E2-F1	BLK 16
	R5-1	+20V	NW8-8	WHT-RED-ORN 22		
	R5-2	+20V	C3 (-)	WHT-RED-ORN 22	XQ4-1	WHT-RED-ORN 22
	R6-1	-20V	NW8-10	WHT-VIO-RED 22		
	R6-2	-20V	C4 (-)	BUS 20	XQ2-1	WHT-VIO-RED 22
	R8-1	+2V Output	VR1-J1-T	WHT-RED-BLU 22	NW7-J1-C	WHT-RED-BLU 22
	R8-2	+20V Output	C3 (+)	WHT-RED-ORN 22	XQ3-3	WHT-RED-ORN 22
	R11-1	Drop. Resis. (-8V)	NW8-11	WHT-VIO-BLU 20		
	R11-2	Drop. Resis. (-8V)	C1 (-)	WHT-VIO-BLU 20	A10-J1-A	WHT-VIO-BLU 20
	R11-3	Drop. Resis. (-8V)	NW8-16	WHT-VIO-BLU 20		

ELECTRONIC ASSOCIATES, INC.
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SHEET 29 OF SHEETS

XQ1,2,3,4 XF1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	XQ1-1	-20V (Collector)	VR1-J1-Y	WHT-VIO-RED 22		
	XQ1-2	-12V (Base)	VR1-J1-U	WHT-VIO-ORN 22		
	XQ1-3	-12V Output	VR1-J1-P	WHT-VIO-ORN 22	XK1-1	WHT-VIO-ORN 22
	XQ2-1	Collector (-20)	R6-2	WHT-VIO-RED 22	VR1-J1-X	WTH-VIO-RED 22
	XQ2-2	Base (-20)	VR1-J1-W	WHT-VIO-RED 22		
	XQ2-3	-20V Output	VR1-J1-N	WHT-VIO-RED 22	AR1-J1-A	WHT-VIO-RED 22
	XQ3-1	Collector (+40)	C5 (-)	WHT-RED-RED 22	VR1-J1-B	WHT-RED-RED 22
	XQ3-2	Base (+40)	VR1-J1-A	WHT-RED-RED 22		
	XQ3-3	+20V Output	R8-2	WHT-RED-ORN 22	VR1-J1-M	WHT-RED-ORN 22
	XQ3-3	+20V Output	NW8-3	WHT-RED-ORN 22		
	XQ4-1	Collector (+20)	R5-2	WHT-RED-ORN 22	VR1-J1-L	WHT-RED-ORN 22
	XQ4-2	Base (+20)	VR1-J1-K	WHT-RED-ORN 22		
	XQ4-3	Emitter Grd	E1-A9	BLK 16		
	XF1-1	115V AC (Hot)	P3-0	(0) BLK		
	XF1-2	115V AC	S4-1	BLK (T #2)		

ELECTRONIC ASSOCIATES, INC.
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SHT. NO	
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PROJECT 1887	B 026 158 0W

SHEET 30 OF SHEETS

C1, 2, 3, 4, 5, C6 B1 and TH1

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	C1 (+)	Filter Grd	T1-15	BLK 16	E7	BLK 16
	C1 (-)	-8V Filter	R11-2	WHT-VIO-BLU 20	DS5-C	BUS 20
	C2 (+)	Filter Grd	T1-18	BLK 16		
	C2 (-)	-110V Filter	AR2-J1-K	WHT 22		
	C3 (+)	+20V Output	R8-2	WHT-RED-ORN 22		
	C3 (-)	+20V Filter	R5-2	WHT-RED-ORN 22		
	C4 (+)	± Grd	S3-1	BLK 16	E1-A1	BLK 16
	C4 (+)	± Grd	NW7-J1-Y	BLK 16	S5-6	BLK 16
	C4 (-)	-20V Filter	K2-13	WHT-VIO-RED 22	R6-2	BUS 20
	C5 (+)	+40V Output	NW8-2	WHT-RED-RED 22	AR1-J1-J	WHT-RED-RED
	C5 (+)	+40V Output	VR1-J1 E	WHT-RED-RED 22		
	C5 (-)	+40V Filter	XQ3-1	WHT-RED-RED 22		
	C6-1	± Grd (Out)	E5 Lug	BLK 20		
	C6-2	± Grd (In)	E2-A2	BLK 20		
	B1-1	117V AC	T1-1	BLK (T #3)		
	B1-2	117V AC Com	T1-2B	RED (T #3)		
	TH1 (+)	6.3V AC	E2-W1	BRN 20T		
	TH1 (-)	6.3V AC (Ret)	E2-V3	WHT-BRN 20T		

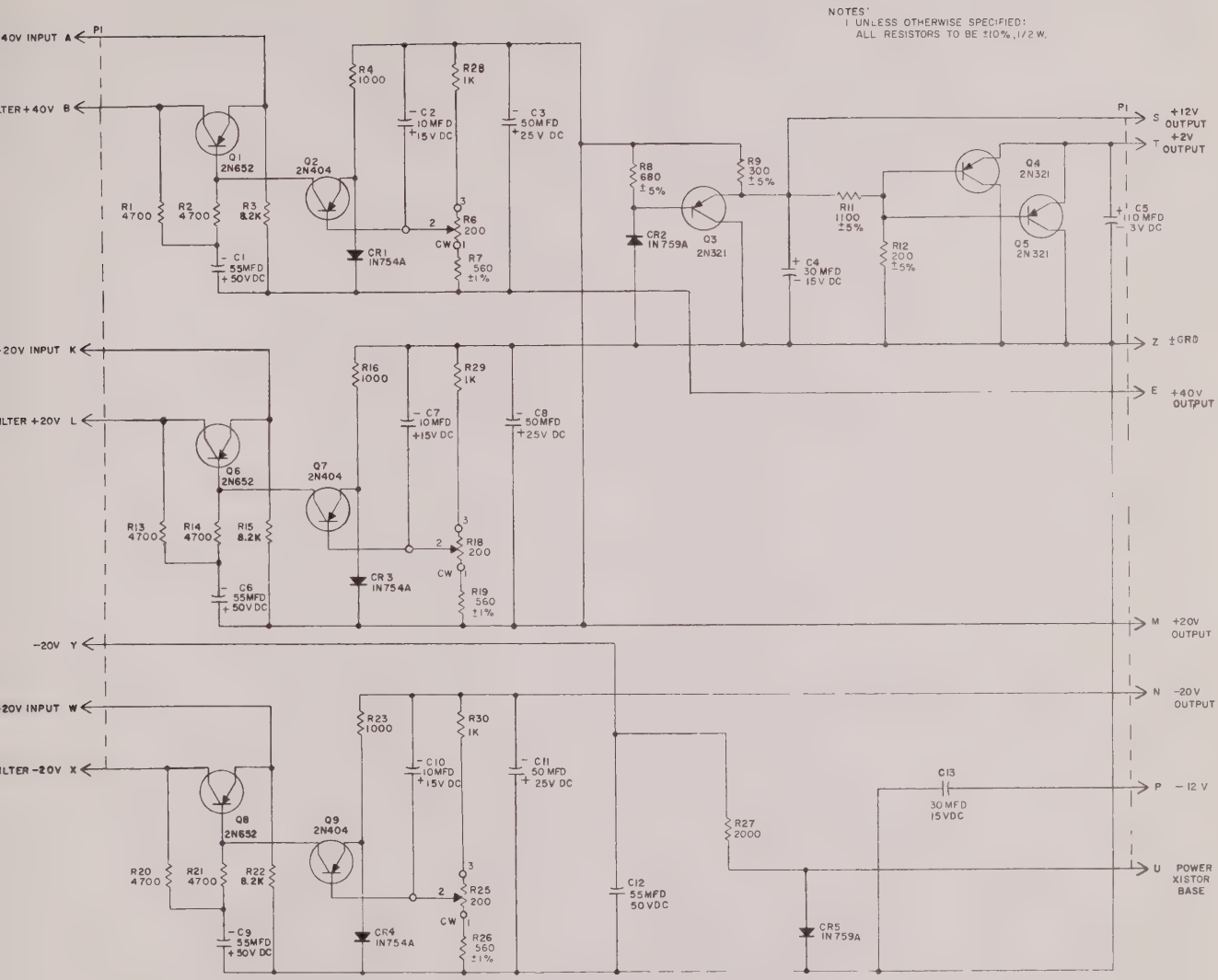
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT NO	
SIZE	
REV NO	
PROJECT 1887	B 026 158 0W

SHEET 31 OF SHEETS

VR1-J1 POWER SUPPLY .EGULATOR 43.094

HARN/CABLE	TERMINAL	FUNCTION	COLUMN 1 DESTINATION	COLUMN 1 WIRE	COLUMN 2 DESTINATION	COLUMN 2 WIRE
	VR1-J1-A	+40V Input	XQ3-2	WHT-RED-RED 22		
	B	Filter (+40V)	XQ3-1	WHT-RED-RED		
	C					
	D					
	E	+40V Output	C5 (+)	WHT-RED-RED	AR2-J1-T	WHT-RED-RED 22
	F					
	H					
	J					
	K	+20V Input	XQ4-2	WHT-RED-ORN		
	L	+20V Filter	XQ4-1	WHT-RED-ORN		
	M	+20V Output	P2-12	WHT-RED-ORN	AR1-J1-D	WHT-RED-ORN
	M	+20V Output	XQ3-3	WHT-RED-ORN		
	N	-20V Output	XQ2-3	WHT-VIO-RED	AR2-J1-M	WHT-VIO-RED
	N	-20V Output	R3-1	WHT-VIO-RED		
	P	-12V	XQ1-3	WHT-VIO-ORN	A6-J1-L	WHT-VIO-ORN
	P	-12V	A11-J1-A	WHT-VIO-ORN		
	R	Key				
	S	+12V Output	A11-J1-B	WHT-RED-ORN	P4-9	WHT-RED-ORN
	S	+12V Output	S5-4	WHT-RED-ORN		
	T	+2V Output	A11-J1-C	WHT-RED-BLU	R8-1	WHT-RED-BLU 22
	U	Base PW 2 Xistor	XQ1-2	WHT-VIO-ORN		
	V					
	W	-20V Input	XQ2-2	WHT-VIO-RED		
	X	-20V Filter	XQ2-1	WHT-VIO-RED		
	Y	-20V Filter	XQ1-1	WHT-VIO-RED 22		
	VR1-J1-Z	± Grd	E1-A2	BLK 16		



ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

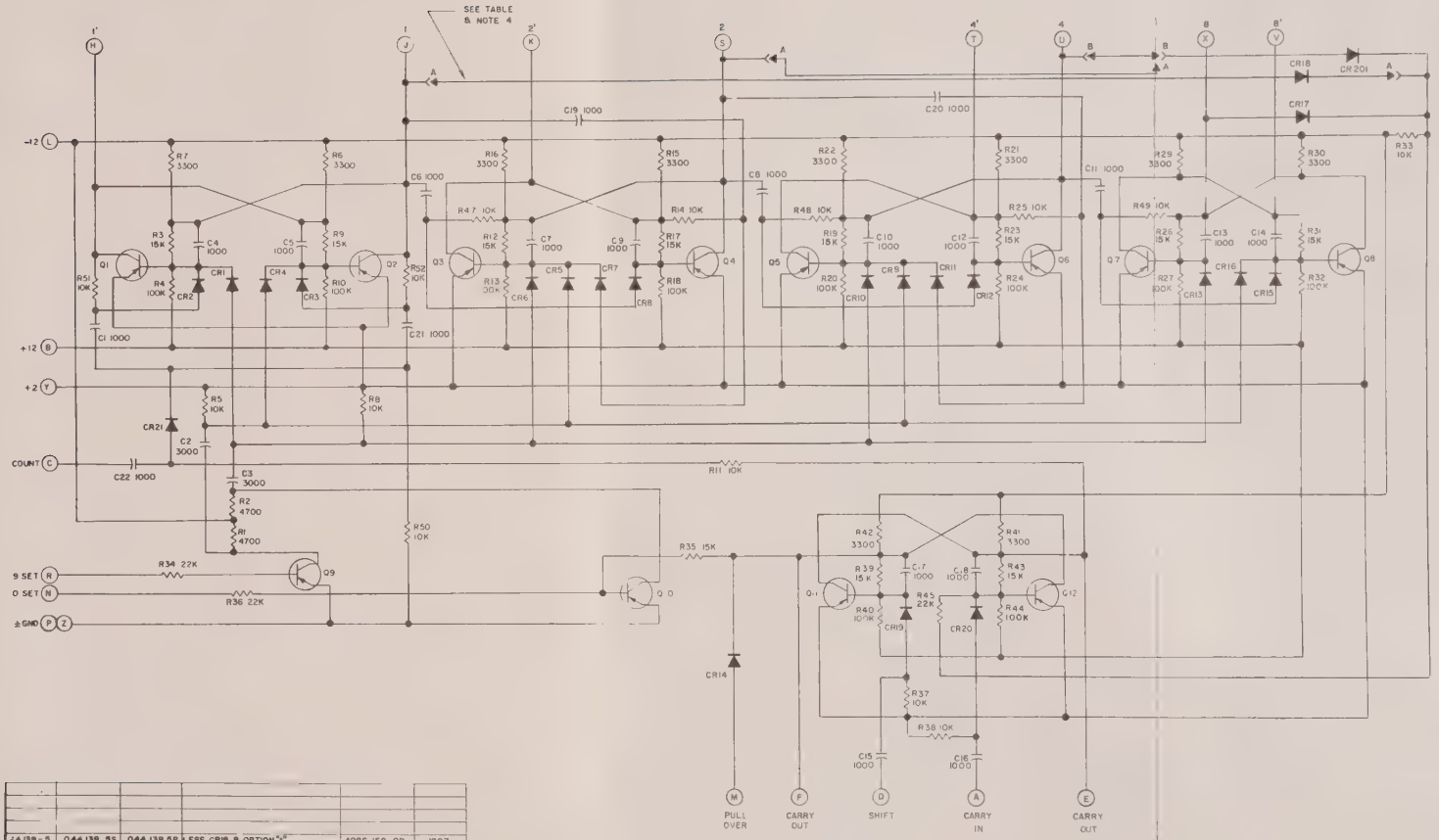
SCHEMATIC

POWER SUPPLY REGULATOR
(SERIES 5001 TDVM)

SHT NO	
SIZE	
REV NO	
PROJECT	1887 C043 094 05

SHEET OF SHEETS

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL TRANSISTORS PER B686 032 O
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE EAI 614043 O
3. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ±10% TOLERANCE 1/2 WATT
4. OPTIONS SHOWN ARE ALTERNATE CIRCUITRY AND/OR CIRCUIT PATHS THEY DO NOT NECESSARILY REPRESENT PHYSICAL JUMPERS



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASS'Y	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
44139-5	044 139 5S	044 139 5P	LESS CR18 & OPTION "A"	A026 158 OP	1887
44139-4	044 139 4S	044 139 4P	LESS CR18, OPTION "A" & LEVER ASS'Y	——	——
44139-3	044 139 3S	044 139 3P	LESS OPTION "B"	A026 156 OP	1423
44139-2	044 139 2S	044 139 2P	LESS OPTION "B" & LEVER ASS'Y.	——	——
44139-1	044 139 1S	044 139 1P	LESS CR201 & OPTION "B"	A026 139 OP	1877
44139	D044 139 0S	A044 139 0P	LESS CR201, OPTION "B" & LEVER ASS'Y	A026 045 OP	1969

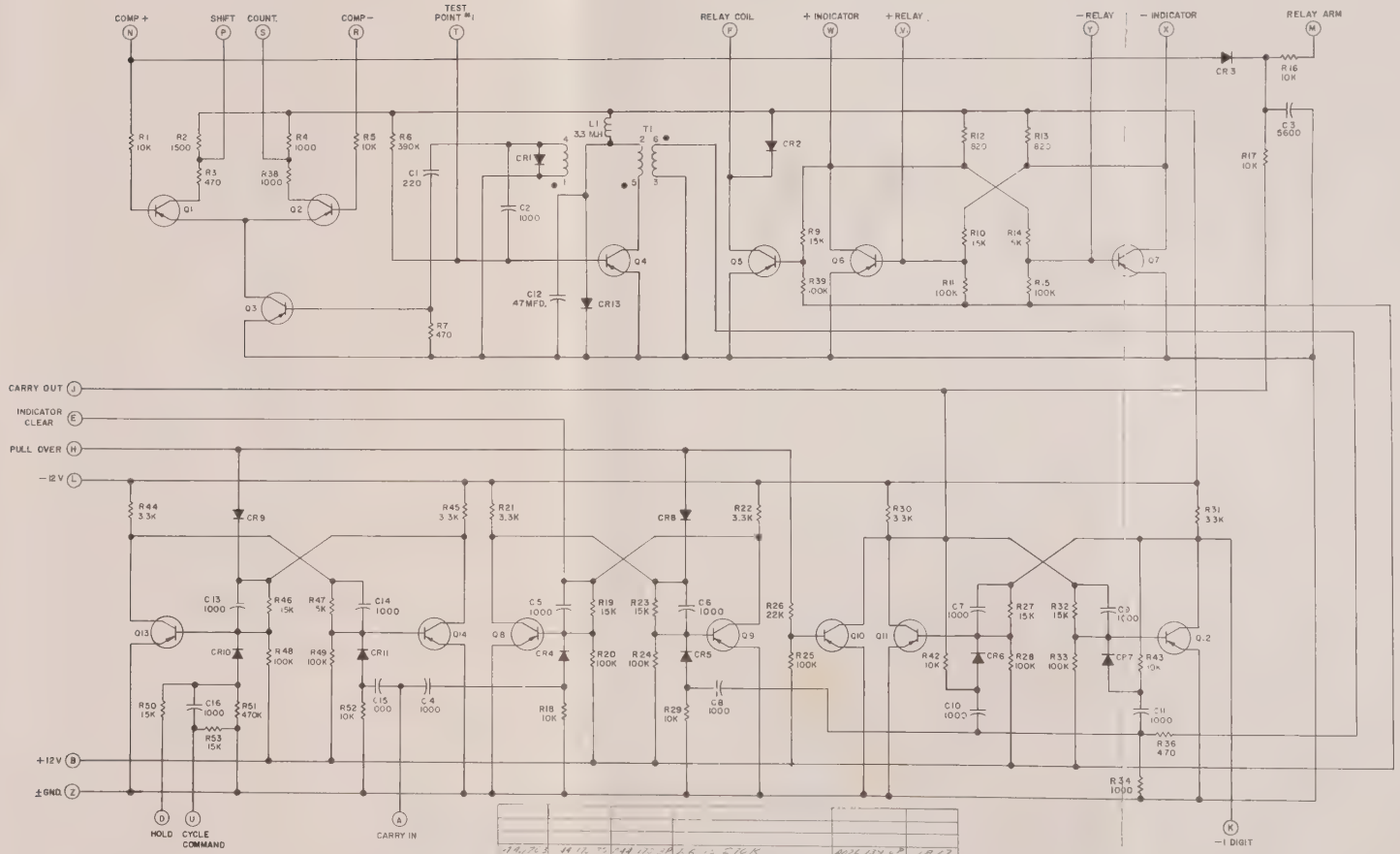
TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES INC
LONG BRANCH NEW JERSEY

SCHEMATIC DIAGRAM
BINARY CODED
DECADE COUNTER

SHT NO
SIZE
REV NO
PROJECT 1969 D044 139 0S
SHEET OF SHEETS

NOTES
1. UNLESS OTHERWISE SPECIFIED ALL TRANSISTORS PER 8686 032 O
2. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 614 043 O OR EQUAL
3. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ±10% TOLERANCE, 1/2 W



UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASS'Y	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
44,176-3	44 12 [illegible]	44 170 SP 1,6	ETCH	A026 134 [illegible]	1017
44,176-2	44 16 25	6491 [illegible]	PARTS LIST	3,270 KS [illegible]	LEVER ASSY
44,17-	44 16 13	6491 [illegible]	[illegible]		
44,17-	D 44 170 SR	[illegible]	[illegible]		

TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

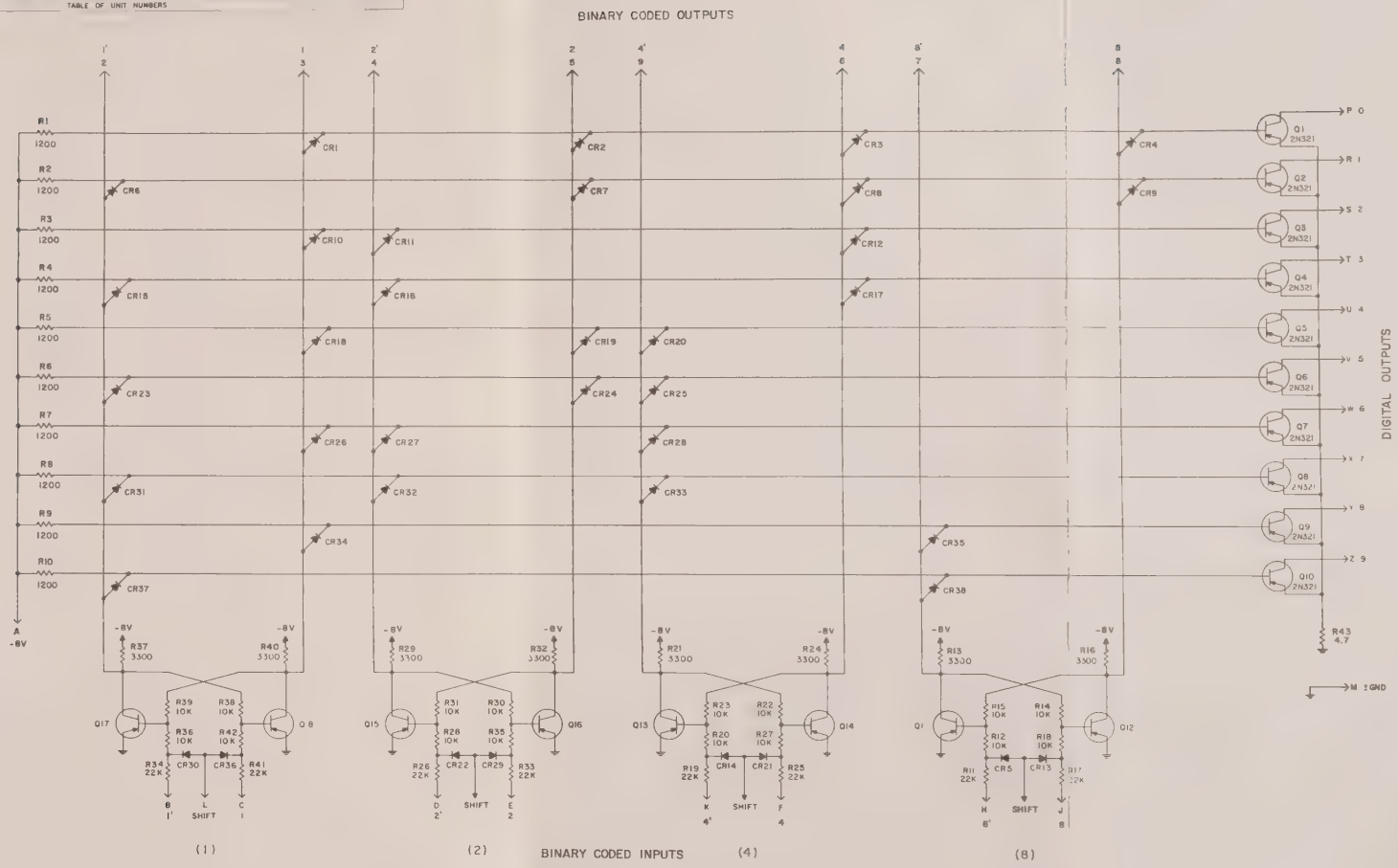
SCHEMATIC DIAGRAM
PROGRAMMER

SHT NO
SIZE
REV NO
PROJECT 1969 D044 170 0S
SHEET 1 OF 1

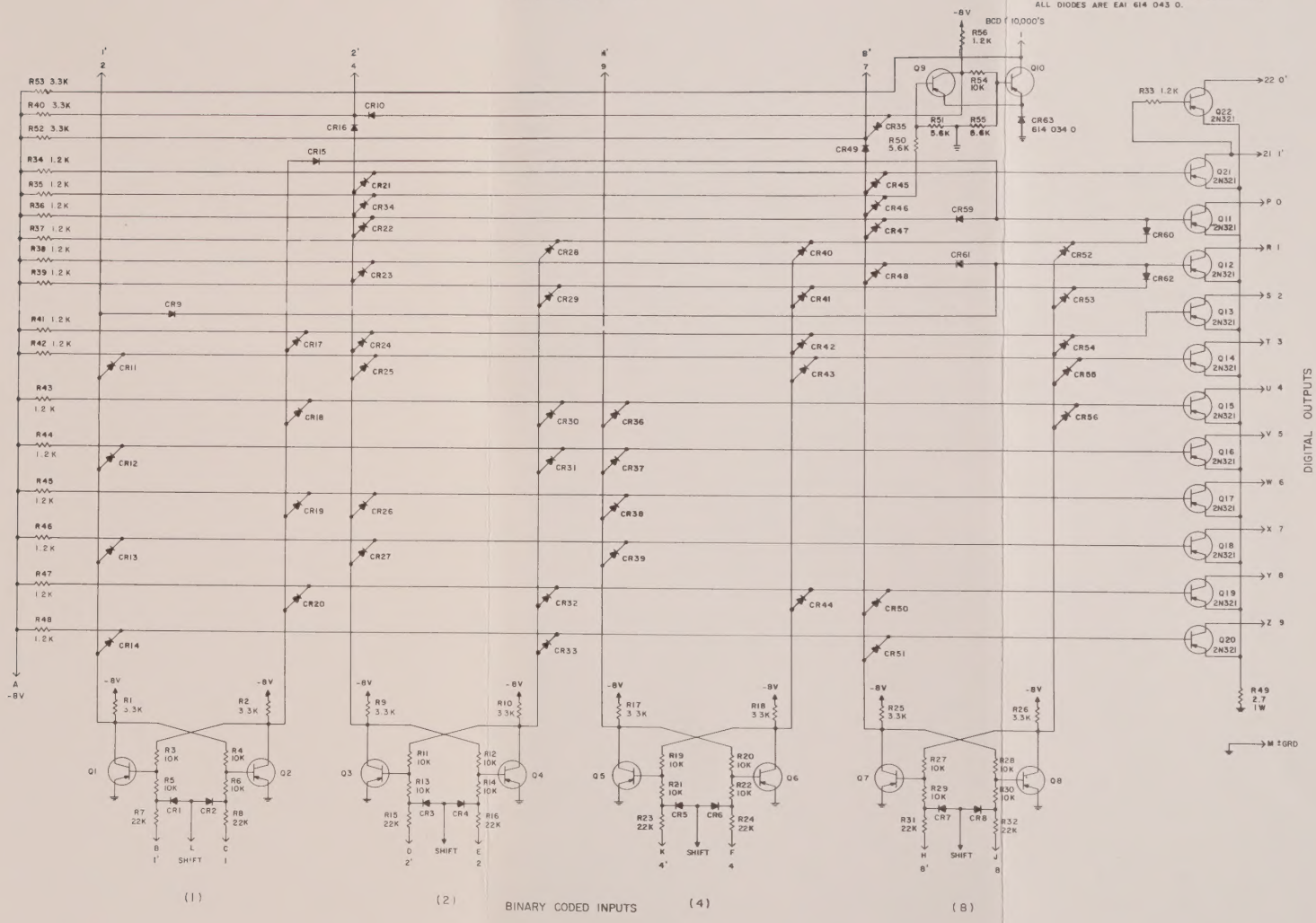
UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER
51 010 -7	051 010 7S	051 010 7P	ELEC. THE SAME AS 51 010-6		
-6	6S	6P	SHT. 2 LESS R15,17,23,25,31,33,39,41		
-5	5S	5P	ELEC THE SAME AS 51 010-4		
-4	4S	4P	SHT 2 LESS R11,14,19,22,26,30,34,38		
-3	3S	3P	ELEC. THE SAME AS 51.010-2		
-2	2S	2P	SHT 2 AS SHOWN	A026 160 0P	1728
-1	1S	1P	ELEC. THE SAME AS 51.010	A026 139 0P	1877
51 010	D051 010 0S	A051 010 0P	SHT. 1 AS SHOWN	A026 048 0P	969

TABLE OF UNIT NUMBERS

NOTES:
(UNLESS OTHERWISE SPECIFIED:
ALL TRANSISTORS PER B686 032 0
ALL RESISTORS ARE ±10% TOLERANCE, 1/2 WATT
ALL DIODES ARE EA1 614 043 0



ELECTRONIC ASSOCIATES, INC
LONG BRANCH, NEW JERSEY
SCHEMATIC
READOUT STORAGE DECADE
SHT NO. 2
SIZE D
REV NO. 0
PROJECT 1969 D051 010 0S
SHEET 1 OF 2 SHEETS



ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC

READOUT STORAGE DECADE
(REMOTE COMMAND RANGE SW) TDVM

SHT. NO.	2 3 4 5
SIZE	D D D D
REV. NO.	0 0 0 0
PROJECT 1423	D051 080 05

SHEET OF 7 SHEETS